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PRINCIPLES

OF

FORENSIC MEDICINE.

PRINCIPLES

OF

RENSIC MEDICINE.

BY

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FOURTH EDITION,

SED, ENLARGED, AND COPIOUSLY ILLUSTRATED BY WOOD
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PREFACE

TO

THE FOURTH EDITION.

THE original aim of this work was to furnish, for teacher and learner alike, a Text-book, in which principles and results should be clearly and briefly stated, disencumbered of minute details, and containing only such illustrative cases as could, for the most part, be compressed into a narrow compass.

But this brevity and condensation were found quite consistent with an original treatment of several subjects, and with a laborious analysis of facts which others had left undigested, and therefore useless or misleading. Of such elaborate analysis, the first edition of this work contained several examples, under the heads of Personal Identity, Infanticide, Legitimacy, and Unsoundness of Mind.

Some of these analyses having served their purpose of demonstrating the uselessness of certain tests and standards of comparison, were omitted from the second edition; many illustrative cases were also either curtailed or set aside, thus leaving room for a considerable number of wood engravings, comprising drawings of seeds, minute structures, and chemical reactions as seen under the microscope. The second edition thus became the first English treatise on Forensic Medicine in which such illustrations were largely used. It also contained some new chemical facts and tests, arising out of the method then recently suggested, of obtaining sublimates of arsenic and mercury, on a

flat surface of glass, so as to admit of ready examination by the microscope.

In the third edition, the original aim of the book was not lost sight of, while the principle of pictorial illustration was carried much farther than in any similar work. Many of these additions had been rendered necessary by the interesting discovery of Helwig, of Mayence, that the method of sublimation on flat surfaces admitted of extension to the alkaloids. The results obtained by this means (so easy of application in all cases, productive of such characteristic appearances in many), were then for the first time described and illustrated; and new diagnostic methods, as well as distinctive tests for some important poisons (especially strychnia, morphia, and cantharidine) were pointed out.

The third edition, therefore, had many attributes of an original work, especially in the Toxicological part, and notably in the chapters on Methods of Procedure, and on the Diagnosis of the Poisonous Alkaloids and Analogous Active Principles.

Of the wood-cuts illustrating microscopic objects, several were taken from photographs by Dr. Julius Pollock.

In preparing this edition, the original Author has had the advantage of the co-operation of his successor in the chair of Forensic Medicine; and the work is, therefore, in part, the production of one actually engaged in teaching. The work has been throughout subject to a double revision, resulting in a considerable condensation of old, and an addition of more than 50 pages of new, matter. Some subjects have been rewritten, others (chiefly toxicological) added, and some leading illustrative cases (among them that of the Welsh Fasting Girl, and the Tichborne case) given at some length.

The Tichborne case was reserved for an appendix, inasmuch as, when the first pages were sent to press, it was still a subject of dispute, and there was reason to hope that, by the time the text was complete, it could be treated as a medico-legal case belonging to the past. In this hope we have been disappointed; but we

felt that to omit all notice of a case having such important and novel bearings on the subject of 'Personal Identity' would be inconsistent with the aims and character of this work.

It should be added that some of the chief additions made under the head of Toxicology are condensed statements of the results of recent researches, at home and abroad, on the mode of action of the several poisons. This portion of the work has been much enriched by Professor Ferrier. Where it was necessary to do so, the work of the original author has been distinguished by the letter, G.

September, 1874.

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PRINCIPLES

OF

FORENSIC MEDICINE.

INTRODUCTION.

The State avails itself of the knowledge, experience, and skill of the medical man for three distinct purposes:—1. For the care of soldiers and sailors, prisoners, paupers, lunatics, and others for whose safety it makes itself responsible; 2. As officers of health; and 3. As skilled witnesses in courts of law.

The duties of the medical man in the first of these capacities do not differ much from those which devolve upon him in the ordinary practice of his profession; but he is expected to give attention to the prevention as well as the cure of disease, and to add to professional skill administrative talent.

As health officers, however, and as witnesses in courts of law, medical men have duties to perform for which the ordinary practice of their profession affords no adequate preparation, medical education, till of late years, no proper training, and medical literature no sufficient guidance.

The distinctness, importance, and difficulty of these duties led at length to the establishment of a distinct science, taught in separate courses of lectures, treated in separate works, and engaging the attention of men more or less separated and set apart for the practice of the corresponding art.

This new science either embraced all the duties the medical man may be required to perform on behalf of the State, in which case it received the name of Political, or State-Medicine; or it was divided into two sciences, the one under the title of Hygiène or Public Health, the other known indifferently as Forensic Medicine, Juridical Medicine, Legal Medicine, or Medical Jurisprudence.

As the term Forensic Medicine expresses with sufficient

clearness the application of medical knowledge to legal purposes, it is used in the title of this work. The term *medico-legal* is also in common use, as in the phrases "medico-legal knowledge," "medico-legal experience," "medico-legal skill."

The history of Forensic Medicine is that of most other sciences. Necessity or convenience gives birth to an art practised by persons more or less skilful, without guidance from general principles; but its importance, and the responsibility attached to the practice of it, soon create a demand for instruction, oral and written, which gradually assumes a systematic form. Thus it was that the Science of Medicine sprang from an empirical art of healing. In like manner, the Science of Forensic Medicine took its rise in the necessity of bringing medical knowledge to bear on legal inquiries relating to injuries or loss of life; the medical witness being at first without guidance in the performance of his duty, and so continuing till a growing sense of the important bearing of his work on the interests of society, and on his own reputation, created a demand for instruction that could not fail of being supplied. Cases were accordingly collected, arranged, and commented on, illustrative facts sought after, special experiments devised and performed, till at length the medical witness received in books and lectures the same distinct instruction as the physician or surgeon at the bedside had already derived from written or oral teaching in the theory and practice of medicine, or of surgery.

But the importance of medical testimony received an earlier recognition from continental governments than from the public or the medical profession; for the earliest State recognition (1507) anticipated by nearly a century the first medico-legal treatise (1597); and the first appointment of medical men to perform medico-legal duties followed soon after, namely, in France in 1603.*

The history of Forensic Medicine in England is of comparatively recent date. It begins with the publication, in 1788, of Dr. Samuel Farr's 'Elements of Medical Jurisprudence,' and was

* The following dates have an historical interest. The penal code of the Bishop of Bamberg, proclaimed 1507. A uniform penal code adopted by the Diet of Ratisbon 1532. The *Constitutio Criminalis Carolina*, published 1553. Letters patent, presented to his first physician by Henry IV. of France, empowering him to appoint two surgeons in every city and large town to examine and report upon wounded or murdered persons, 1603. Publication at Frankfort of the Methodus Testificandi of Condronchus, 1597, and of the works of Fortunatus Fidelis and Paul Zacchias in 1598 and 1621. First course of lectures on Forensic Medicine given by Michaelis at Leipzig about 1650. For a learned history of legal medicine, see Traill's 'Outlines of Medical Jurisprudence.'

first taught in lectures at Edinburgh, in 1801, by Dr. Duncan, sen., the first professorship being conferred by Government on his son in 1803. The new science soon justified the distinction thus conferred upon it, and made good its claims to more general recognition. It now enters into the curriculum of most of the examining bodies; it is taught in all our medical schools; its principles are being constantly applied in our courts of law; and England is contributing her fair share of observation and research towards its extension and improvement.

The application of the principles of the science—in other words, the practice of it as an art—devolves, for the most part, on the medical practitioner. It is only occasionally that those specially versed in the entire subject, or in important parts of it, such as Toxicology, or eminent in certain branches of practice, such as midwifery and the treatment of the insane, are summoned to give evidence.

There are many reasons why the medical man should approach this class of duties with apprehension. He is conscious of the importance that attaches to his evidence; he is wanting in the confidence which a more frequent appearance as a witness would impart; he is painfully alive to the unstable foundation on which many medical opinions rest; he knows that it is not easy in practice to observe the rules of evidence with which in theory he may have made himself acquainted; and, above all, he shrinks from the publicity attendant on legal proceedings, the unreasonable licence allowed to counsel, and the disparaging comments of the Bench itself. Sympathizing in these reasonable apprehensions, some writers of eminence and most authors on Forensic Medicine have tried to prepare the medical witness for his duties by setting forth the precautions he should observe both prior to and during his attendance in court; and by special directions for conducting medico-legal inquiries under the heads of "Post-mortem inspection," "General evidence of poisoning," "Unsoundness of mind," &c.; the general precautions to be observed in the witness-box being made the subject of distinct treatment under the title MEDICAL EVIDENCE. This distinction is observed in these pages.

Before treating of the duties of the medical witness, it may be well to show the number of cases that occur year by year in England and Wales of a class to give rise to medico-legal inquiries. The Annual Report of the Registrar-General for the year 1871, records the following figures.

Deaths by accident or negligence . .	15,984
„ „ suicide	1,495
„ „ murder and manslaughter . .	381
Other violent deaths (not classed) . .	156
	18,016
Sudden deaths (causes unascertained) . .	3,155
	21,171
Premature births, malformations, atrophy and debility	41,110
Total . . .	62,281

The following are some of the special causes of death comprised in the first two lines of the foregoing table.

Causes of Death.	Accident or Neglect.	Suicide.	Total.	Males.	Females.
Poison	261	131	392	233	159
Fractures and bruises .	6,837	—	6,837	5,777	1,060
Gunshot	102	63	165	157	8
Cuts and stabs	111	301	412	339	73
Burns and scalds . . .	2,612	—	2,612	1,355	1,257
Drowning	2,605	317	2,922	2,348	574
Hanging	—	548	548	448	100
Suffocation	1,504	—	1,504	876	628
Lightning	28	—	28	23	5
Total	14,060	1,360	15,420	11,556	3,864
Otherwise	929	135	1,064	782	282
Grand Total	14,989	1,495	16,484	12,338	4,146

The deaths by accident or negligence were distributed between the sexes as follows:—Poison, men 159, women 102; Gunshot, men 94, women 8; Cuts and stabs, men 93, women 18; Drowning, men 2175, women 430; otherwise, men 683, women 246.

The suicides were distributed as follows:—Poison, men 174, women 57; Gunshot, men 63, women 8; Cuts and stabs, men 246, women, 55; Drowning, men 173, women 144; Hanging men 448, women 100; otherwise, men 99, women 36.

The premature, sudden, and violent deaths gave rise to 25,898

inquests, of which 17,916 on the bodies of males, and 7982 on those of females: and as the qualified practitioners in England and Wales fall far short of this number, it follows that, if the duty of attending at inquests were distributed equally, each member of the profession would attend at least one inquest every year.

The committals for trial arising out of these 25,898 inquests amounted to 402, of which 226 were for murder, and 176 for manslaughter. In 1464 instances the death was returned as suicidal.

The number of cases requiring medical evidence in our higher courts of law may be judged of approximatively from the printed returns of commitments for trial for offences against the person. In the year 1870–71 these amounted to 2416, and comprised—

Murder and attempts to murder . . .	181
Various attempts to maim and injure . .	634
Assaults	495
Manslaughter	273
Concealment of birth	138
Rape and assaults with intent . . .	558
Unnatural offences	137
	2416*

If we add to the occasions for medical evidence arising out of these crimes, the civil cases in which skilled medical evidence is required, and proceedings in respect of lunatics, the occasions on which medical men are summoned to courts of law, either in the service of the State, or on behalf of individuals, will appear very considerable—certainly numerous enough, and important enough in themselves, to justify all the attempts which have been made to construct a science of Forensic Medicine, to teach it systematically in books and lectures, and to draw up a code of instructions for the guidance of the medical witness in the performance of his duties.

MEDICAL EVIDENCE.

The medical man may be summoned as a witness to *state* facts, and to *interpret* them. He may be examined as to the facts he has himself witnessed, and he may be questioned as to his interpretation of them. In the one case he is a *common* witness, in the other a *skilled* witness, or *expert*. In the majority of cases

* These figures are taken from the annual report, entitled 'Judicial Statistics,' 1872.

he acts in both capacities. As a skilled witness, he may also be required to give his opinion on the facts observed, and the views expressed, by others.

In performing these duties there are certain precautions which the witness ought to observe, and certain legal requirements of which he should not be ignorant.

1. He should "use his best endeavours that his mind be clear and collected, unawed by fear, and uninfluenced by favour or enmity." (Percival.) He will not find it easy to maintain this impartial frame of mind when the crime alleged is one of unusual enormity; when popular feeling runs high for or against the accused; or, in times of public agitation, when his evidence tends to discredit some popular movement, or deep-rooted prejudice. Nor, when he is engaged as a skilled witness, or *expert*, for the prosecution or for the defence, must he deem himself free from the risk of partiality, even though, after hearing all the facts which should influence his opinion, he feels that he can conscientiously give his evidence in support of the side for which he is retained.

2. The medical witness requires to be specially cautioned against expressing an opinion on the general merits of the case under inquiry, thus offending against an admitted principle of English law, that "when scientific men are called as witnesses, they are not entitled to give their opinion as to the *merits of the case*, but only as to the *facts proved on the trial*.

3. A special caution is also required against indulging a feeling of misplaced humanity, or an equally misplaced condemnation of the law on the score of undue severity. Both these feelings too often found expression in former treatises on the lung-tests, and early trials for infanticide. But the witness should understand that he is not responsible for the consequences to which his opinions may lead, provided always that they are the result of cautious inquiry and due reflection. Percival accordingly treats "The dread of innocent blood being brought upon us by explicit and honest testimony," as "one of those superstitions which the nurse has taught, and which a liberal education ought to purge from the mind."

The witness approaching his duties with a mind thus free from bias, requires some instruction as to the mode in which his evidence should be given.

1. Bearing in mind the distinction just laid down between a common and a skilled witness, he should be cautious not to obtrude his opinions when facts only are required of him, nor dogmatically to assert as facts things which are merely matters of opinion. He should answer the questions put to him, whether

by counsel, court, or jury, clearly and concisely, and if these do not elicit the whole truth, supply what is wanting.

2. His statements should be made, and his opinions expressed, in the plainest and simplest language; and he should avoid as much as possible all technical terms, and all figurative and metaphorical expressions.

3. The medical witness ought also to abstain from quoting authorities in support of his opinions; for though the rule of exclusion has not always been rigidly acted on, the common usage of our courts of law is certainly to disallow these appeals. Nor is this exclusion open to any serious objection, for the witness is supposed to make himself master of the views of the most eminent writers on the subject-matter of his evidence, and to use them as aids and guides to his own special inquiries.

But though the witness may not cite authorities, he may be asked whether A or B is an esteemed authority with his profession, and whether he (the witness) coincides with some opinion expressed in his works. If the witness answers in the affirmative, he becomes the exponent of the opinion to which he thus gives his assent.

The foregoing observations relate chiefly to the mode in which the witness should give his evidence. The precautions to be observed in order that his evidence may be admissible still remain to be considered, under the following heads:—

1. *Notes.*—When observing any facts which, at a future time, may become the subject-matter for legal inquiry, the medical man should not trust to his memory, but commit them to writing, either on the spot, or as soon as possible after the transaction to which they relate. If (as in performing a post-mortem examination) it is necessary to resort to dictation, the notes of the amanuensis should be immediately examined and corrected.

The witness may use these notes in court to *refresh* his memory, but not to supply its place. If they were not made till some time after the events to which they refer, or if, having been made at the proper time, they have been entirely forgotten, they will not be admissible.

2. *Confessions.*—A culprit may make a confession of guilt to his medical attendant. This, to be admissible in a court of law, must be free and voluntary, uninfluenced by threat, promise, or bribe. No sort of inducement should be held out to make it, no leading questions should be put, and no comments made; but the medical man should reduce the statement to writing as soon as possible, read it over to the person confessing, obtain his signature to it, and countersign it himself.

At the same time the greatest care should be taken to ascertain the bodily health and mental state of the party making the confession. The necessity of this caution has been amply proved by cases in which, during febrile attacks, or after prolonged exposure and hardship, confessions have been made of murders and other heinous crimes which had never been committed. In times now happily passed away, innocent persons, under like conditions of body and mind, made confession of impossible crimes, such as witchcraft.

3. *Death-bed Declarations.*—These are admitted as evidence in cases of homicide, where the death of the deceased is the subject of the charge, and the circumstances of the fatal injury the subject of the declaration. It is assumed that the declarant, having lost all hope of recovery, is induced to speak the truth by considerations as powerful as an oath administered in a court of justice. It is not necessary, however, that he should *express* his conviction. It may be inferred from the nature of the injury, or from other circumstances of the case. But if any hope whatever be entertained, or may be inferred to exist, whether it be spontaneous or on the suggestion of others, death-bed declarations cannot be received in evidence.

But the person, or persons, inculpated by the declarant's statement, are not precluded from giving evidence as to his state of mind and behaviour in his last moments. They may be allowed to show that the deceased was influenced by vindictive motives, or was not of a character to be "impressed by a religious sense of his approaching dissolution."

As dying declarations are but confessions of the most solemn kind, the same rules of procedure apply to them as to confessions. The medical man should put no leading questions, but only such as are necessary to clear up ambiguity. He should commit the declaration to writing, read it to the dying man, and obtain his assent, and, if possible, his signature to it. But if this cannot be done, he should make a memorandum of the declaration at once, while it and the words used are fresh in his memory. To this document the witness will be allowed to refer to refresh his memory when he comes to give evidence. Another essential part of his duty is to ascertain the exact state of the declarant's mind, whether he is calm and collected, or otherwise, and whether he is under the influence of any strong bias, or undue feeling of resentment.

4. *Hearsay.*—This is not admissible as evidence unless it form part of the *res gesta*. A medical witness, therefore, though he may state in evidence the words he has heard used in direct

by counsel, court, or jury, clearly and concisely, and if these do not elicit the whole truth, supply what is wanting.

2. His statements should be made, and his opinions expressed, in the plainest and simplest language; and he should avoid as much as possible all technical terms, and all figurative and metaphorical expressions.

3. The medical witness ought also to abstain from quoting authorities in support of his opinions; for though the rule of exclusion has not always been rigidly acted on, the common usage of our courts of law is certainly to disallow these appeals. Nor is this exclusion open to any serious objection, for the witness is supposed to make himself master of the views of the most eminent writers on the subject-matter of his evidence, and to use them as aids and guides to his own special inquiries.

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PART I.

CHAPTER I.

PERSONAL IDENTITY. AGE. SEX.

When called upon to examine the body or remains of some unknown person, we may have first to ascertain the sex and the age, and then to identify the individual by characteristic marks; or these points may have to be considered separately, sometimes in living, sometimes in dead persons. In this chapter, the three subjects are grouped together, and placed in the most convenient order; sex in the last place, from its connexion with the topics contained in Chapter II.

PERSONAL IDENTITY.

Questions of identity are often raised in courts of law; as when a claim is set up to an inheritance, or a man who has been robbed has to identify the thief, or a witness an acquaintance; and when a prisoner makes his escape from prison, and is retaken, a jury may be empannelled for the sole purpose of trying the question of his identity. So also as to persons found dead; and in coroners' inquests the first step taken is to identify the body, or such parts of it as are forthcoming.

The subject of personal identity, then, divides itself into, 1, *The Identity of the Living*; 2, *The Identity of the Dead.*

I. IDENTITY OF THE LIVING.

The medical man may be required to examine, with a view to identification, alleged deformities or injuries, scars, or discolourations that may have been brought about in the skin or hair; also to express an opinion on the changes that may be wrought in stature, face, and person by time, exposure, and hardship. It would also be within his province to give evidence

on the changes which may be brought about by like causes in the mind and memory. In order to give completeness to the subject, some questions will be briefly noticed in which medical evidence is not needed.

In cases of disputed inheritance, much stress is laid on family resemblance. The celebrated Douglas Peerage case was decided in favour of the claimant, Archibald Douglas, in consequence of his proved resemblance to Colonel Stewart, his father, the twin brother, Sholto, who died young, having equally resembled Mrs. Stewart, the mother. In this case, Lord Mansfield strongly insisted on likeness as an argument of a child's being the son of a parent; on the fact that in an army of one hundred thousand men every man may be known from another; and that even when there is a likeness of feature, size, attitude, and action, there may be a difference in the voice, gestures, smile, and various other things.

Though these observations generally hold good (and not of men only, but of herds of cattle and flocks of sheep), still there are many facts on record to prove that persons having no connexion by relationship or descent may yet bear the closest resemblance to each other. Of this mistaken identity, Lord Chief Justice Cockburn, in the Tichborne case, gave more than one illustration, and especially a case on the Western Circuit, in which two men were tried for murder, and convicted. The identity of one of them was sworn to by numerous witnesses; but it was proved afterwards, beyond all possibility of doubt, that they were mistaken; for he was, at the very time of the murder, undergoing punishment for picking a pocket hundreds of miles away. Perhaps the most curious case of this kind occurred more than a century ago (in 1772), when one Mall, a barber's apprentice, was tried at the Old Bailey for robbing a Mrs. Ryan. The witnesses swore to his identity, and the whole court thought him guilty; but, on referring to the books of the court, it appeared that on the day and hour of the robbery he was on his trial at the bar where he then stood for another robbery, in which he was likewise mistaken for the thief.

When the question of identity turns on the changes which time, coupled perhaps with the fatigues, hardships, and privations of a military life, may work in the personal appearance, it becomes one of unusual difficulty. Zacchias was consulted in a case of this class. It was that of Cassali, a noble Bolognese, who left his country at an early age, and was supposed to have died in battle; but, after thirty years, returned, and claimed his property which his heirs had appropriated. The change in his

appearance was so great, that he was imprisoned as an impostor. But as Zacchias in his report, expressed his opinion that such a change might have been wrought by age, change of climate, diet, mode of life, and disease, and Cassali had left home in the bloom of youth, had been exposed to the hardships of a military life, and, if he might be believed, had languished for years in prison, the judges, influenced by this opinion, and by the fact that the heirs could not prove the death of Cassali, decreed the restoration of his estates.

The general question thus submitted to Zacchias assumes a more definite form when, as in the French cases of Baronet and Martin Guerre, a false claimant is confronted with a real one, or alleges his identity with a person long since dead, as in the Tichborne case;* or when, as in this case, the claimant is alleged not only not to be the man he is personating, but some other person.

In all such cases of disputed identity, great importance has naturally attached to the existence, or otherwise, of certain personal marks, such as nævi, moles, deformities, scars of foregone disease or injury, and tattoo markings, on which medical men are required to state their opinion. The Tichborne case has also given renewed importance to questions relating to the effect of lapse of time in changing the stature, form, and features, and in destroying or modifying the memory and habits of thought, as expressed in words spoken or written. That case has also shown the importance that may attach to photographs, as the most exact representation possible of the personal appearance at the time when they were taken. The subjects of scars and tattoo markings are deserving of special consideration.

1. *Scars.*—When a claimant presents himself without the marks or scars known to have characterized the individual whom he personates, his case must break down; but if, on the contrary, these marks or scars are found upon him, they must be looked upon as the strongest possible evidence in his favour, and would, indeed, be conclusive but for the possibility of their having been fraudulently imitated, or of their being most improbable, but still possible, coincidences. That such coincidences may happen, is proved by a case quoted in Beck's 'Medical Juris-

* The reader will find the cases of Cassali, Baronet, and Martin Guerre, with other leading cases from the 'Causes Célebres,' quoted and criticised by Foderé, in the second chapter of his 'Traité de Médecine Légale;' and he is referred for a lucid account of the extraordinary case of Martin Guerre to the columns of the *Times*, December 12, 1871. It is the case in which Arnauld de Tilh, who had possessed himself of the secrets of Martin, contrived to be recognised by his family, and even accepted, seemingly in good faith, by Martin's wife. (See a brief abstract of this case at p. 28).

prudence' (Age and Identity). Joseph Parker, tried at New York in 1804, for bigamy, was mistaken for one Thomas Hoag, whom he not merely resembled, but had in common with him a scar on the forehead, a small mark on the neck, and a lisp in his speech; but, unlike Hoag, he had no scar on his foot. That he was Parker, and not Hoag, was proved to the satisfaction of the jury by an alibi.

The question of identity has sometimes turned on the possibility of removing scars, and some difference of opinion has been displayed upon this point. Thus, in a Belgian case that occurred in 1847, one medical man, M. Vandelaer, stated that scars might be removed by time or by artificial means, and the physicians of the prisons of Valvorde and Ghent confirmed this opinion by stating that prisoners are in the habit of effacing scars by applying a salted herring to them. MM. Lebeau and Limanges, on the other hand, contended that scars could not be removed. On this subject, Casper states that the length of time during which a scar subsists depends on the depth to which the tissues of the skin have been injured. Scars of injuries which have only affected the epidermis, or scarf skin, or penetrated but slightly into the true skin, may entirely disappear. Hence needle scratches, and even some venæsection wounds, leech bites, and the marks of cupping-glasses, may completely disappear. But we may confidently assert that wounds which have penetrated the whole depth of the cutaneous tissues, and *à fortiori*, such wounds, injuries, or ulcers as have caused loss of substance, followed by granulation, leave permanent scars.

Scars may, however, be much altered by time, and considerably modified by friction, pressure, or the use of irritants. But though obscured by such means, they may easily be brought into view. Thus, Devergie states that when the brand-mark of the galley-slave has apparently disappeared, it may be rendered visible by slapping the spot with the hand till it reddens. The white scar thus becomes visible on the reddened skin. The belief that scars may wholly disappear is probably founded on the very slight marks left by extensive wounds when they heal by what is technically called the "first intention." Thus, in the case of a maniac who had completely removed the parts of generation, the place of the wound was marked by a faint white line which might be overlooked by a casual observer; and the severe floggings of former times, which left the back quite raw, are traceable after some years only by very fine white lines upon the back and sides, and, where the knots had fallen, by little circular pits. In a case in which we were consulted, the entire absence of both kinds

of mark enabled us to state with confidence that the man could not have been, as was alleged, very severely flogged (G). Of the permanency of such scars as those left by bleeding, a good illustration is afforded by a case in which two physicians, one 66, the other 64 years of age, having distinct recollection that they were bled in the arm at about the age of 7 years, and not since, the marks of the operation were, in both cases, perfectly distinct.

The exact shape and character of a scar may render great assistance in determining a question of identity. Thus the operations of bleeding, cupping, and vaccination, like the punishment of the lash, leave highly characteristic appearances. So also do burns and scalds, blisters, caustic, tartar emetic ointment, issues, and setons. Diseases, again, such as small-pox, scrofulous ulcers, ulcers on the legs, lupus, and carbuncle, leave indelible marks behind them.

All scars, without exception, pass through two distinct stages—that of inflammatory redness (the immediate consequence of the injury sustained), and that of brown discolouration. In phlegmonous erysipelas, and after the application of blisters, mustard poultices, and such like irritants, the skin, which was red during the inflammatory stage, assumes a dark brown or coppery hue, which it retains for months, and even for three or four years; but at length, and by degrees, the skin resumes its healthy colour. But sometimes, when the inflammation runs high, the brown discolouration is followed by a third stage, or that of bleaching. Thus we have seen, after the lapse of two years and a half, the spot to which a large blister had been applied defined by a white margin, and white decolouration occupying the whole surface on a level with the surrounding healthy skin. Such *surface scars* follow the less severe forms of herpes, boils which have healed after slight destruction of texture, and even incised wounds and lancet cuts, where the edges have not been brought together, and some slight superficial ulceration has taken place. In those cases in which the inflammation, however produced, is followed by ulceration, and consequent destruction of tissue, and still more where gangrene sets in, the scars are wholly or in part sunk beneath the surface. In these cases, the scar passes through all the three stages of inflammatory redness, brown discolouration, and bleaching; and the cause of the scar may often be inferred by the appearance it puts on, aided by the situation in which it is found. Thus a linear scar, or a round or oval surface scar on the arm, ankle, or temple, follows bleeding; parallel linear scars on the loins, shoulders, nape of neck, or other fleshy part of body,

follow cupping; a crucial linear scar on any part of the body would indicate a boil treated in the usual way; two parallel linear scars on the nape of neck, shoulder, or inner side of upper arm, would mark a seton, and a depressed, puckered scar on the same parts, an issue; a honeycombed disc near the insertion of the deltoid muscle indicates the operation of vaccination; a white disc with dotted border may follow a boil that has healed without operation; and every form of cicatrix in the neck, on the chest, and on other parts of the body, may follow scrofulous abscesses. Scrofula, syphilis, and lupus, in common with injuries by gunshot, burns, and escharotics, may leave behind them scars of every size and form. It can scarcely be necessary to add that the healing of scars must be influenced by many causes, such as age, constitution, and states of health, their situation on flat, rounded, or hollow surfaces, on parts subject or not subject to motion, and in the direction of muscles or across them. The distinctness of scars will also vary with the complexion, and the tint of the parts adjacent. Thus scars are less apparent in persons of fair complexion, when the skin approaches in tint to the whiteness of the scar itself, and more distinct over a blue vein or discoloured portion of skin. Hence it is that scars are rendered more visible when the skin is reddened by blows or friction.

Age of scars.—As has just been stated, all scars, whether arising from injury or disease, are first red, then brown, then white and glistening. The redness, as a rule, lasts for two, three, or four weeks, during the period of healing; the brown discolouration for several months, or even for a few years; the bleached appearance for the rest of life. But the length of each stage is subject to much variation. In some cases of small-pox, for instance, the scars are white and shining at the end of six months; in others, they remain brown even after two or three years; and scrofulous ulcers will sometimes leave coloured scars for the whole of life. A scar, then, that retains its inflammatory redness cannot be of long standing; one that has a brown or coppery colour may have existed for months or years; a white, glistening scar, quite free from colour, must have been of long standing, but we cannot even guess at its age.

Some scars are particoloured, perhaps brown in the central parts, with a white, puckered halo, or white in the centre, with a margin of brown spots. Such was a scar from a boil of ten years' standing. It was a white disc, with a circular margin of brown spots. Sometimes we have an opportunity of comparing a comparatively recent scar with one of longer standing

from the same cause, as in a prisoner who had two attacks of herpes, one under the right, the other under the left clavicle. The first, of a few months' standing, displayed the rash in all its details in dark brown; the second, of many years' standing, consisted of a group of scattered white cicatrices.

2. *Tattoo markings.*—The presence or absence of these marks may, as in the Tichborne case, prove of the first importance; and the question naturally arises whether these marks can disappear or be removed. Most tattoo marks are certainly indelible if not interfered with. But that they may in some cases disappear is proved by the observations of Casper, Hutin, and Tardieu; though these authorities differ widely as to the proportion of cases, Casper alleging the high fraction of 1 in 9, Tardieu the much lower one of 1 in 25. Much depends on the kind of the colouring matter employed; and Cinnabar, blue ink, and common ink create less permanent marks than Indian ink, soot, or washing blue, coal dust, or gunpowder. Skilfully performed tattooing with gunpowder may be pronounced indelible. The difference depends on the relative solubility of the colouring matters. When they disappear the colouring matter is found deposited in the nearest absorbent glands, where it may be found after death. The absorption of the more soluble matters is rarely so complete as not to leave some traces behind.

Tattoo markings may be removed artificially; but if the pigment be deep in the skin, a cicatrix will be left in the spot where the marks existed. An experiment was made by Tardieu on a prisoner who had a crucifix tattooed with Indian ink on his fore-arm. After several applications of acetic acid, potash, and hydrochloric acid, a crust fell off at the end of fourteen days, leaving only a flat scar, without a trace of the original design. Escharotics will, of course, cause the disappearance of tattoo marks; but their place will be indicated by a permanent scar, and that scar sunk more or less below the level of the skin.

In regard, then, to tattoo marks we may say that most of them are indelible, but that some may disappear partially, a few entirely; and that if, in a dead body, these marks have disappeared, the colouring matter will be found in the nearest lymphatic glands.

Rules for examining Scars.—Place the scar, if possible, in the bright light of the sun, and, in the case of small and delicate scars, use a lens. Measure the scar carefully with compasses, and note its exact dimensions. Record the form and colour of the several parts of which it consists. Redden the surrounding skin by blows or friction. Note whether it is on a level with, or

sunk beneath, the surrounding surface; and whether it moves with the skin or remains fixed.

Identification by Photographs.—Photographs may mislead when used in respect of the limbs, hands, feet, and parts that are not in focus. But they may render great service when we are dealing with parts in the same focus, such as the features of the face. But this remark applies rather to the fixed features than to the expression, which is not quite the same in any two photographs taken by the same master. Even the outlines of the fixed features may vary according as they are in light or in shadow. In the Tichborne case photographs of Roger Tichborne, of the Claimant, and of members of the Orton family, were all used at the trial; and were so far serviceable as to show that the Claimant's face, and especially the ear, differed widely from that of Roger Tichborne twenty years before, and also that the Claimant bore a nearer resemblance to members of the Orton family than to Roger.

Identification by Stature and Girth.—In the Tichborne case these points came into play. Arthur Orton's Register ticket, issued when he was 18, showed that he was 5 feet 9½ inches in his shoes, or 5 feet 9 inches in his stockings. The Claimant, carefully measured in his stockings in prison, was also 5 feet 9 inches. If, then, Arthur Orton stopped growing at 18, he and the Claimant might be one and the same person. But as men, one with another, grow two inches by the time they reach 30, there is a strong probability in favour of Orton having grown taller, and therefore against the Claimant and Orton being one and the same. In the case of Roger Tichborne, the Carabineer, the stature and girth of the chest were also put in evidence.*

Identification has been effected by comparing a recent wound with the part detached from it. In January, 1846, when freshly-fallen snow was on the ground, a robbery was committed at Stigny, in the house of two old men. Next morning several spots of blood were seen on the floor on the left of a chest of drawers which the robbers had forced.† Other spots were found on the snow in the direction taken by the robbers when they quitted the house, and always on the left-hand of the footsteps. A shred of membrane was also found on the road, which proved to be a portion of skin. On searching the neighbourhood, a man was found with his *left* hand wounded. Dr. Lemoine and M. Cœurderoi

* As the Tichborne case is of very recent occurrence, and it is possible that some fresh light may soon be thrown upon it, we reserve the condensed history of the case, which we had prepared for this part of our work, and shall insert it with such corrections as may be necessary, in an appendix.

† Consult Casper, vol. i. p. 105.

were appointed to examine him; and they agreed that the wound was probably inflicted about the date of the robbery, and that the piece of skin, judging from its size and shape, had formerly covered the injured part. The accused confessed the crime. ('Annales d'Hygiène,' Jan. 1847.)

Fradulent discolouration of the hair.—The question whether hair can be turned from dark to light was raised in Paris in 1832, on the occasion of the trial of one Bénoit for murder. Certain witnesses deposed to having seen him in Paris at 2 p.m. with black hair; while others declared that they saw him at Versailles, at 5 or 6 o'clock the same evening, with fair hair. The colour of the man's hair was jet black, and it does not appear that he wore a wig. The tribunal consulted Orfila, and Michalon, one of the first hair-dressers of Paris, as to the possibility of changing the hair from dark to light. Michalon replied in the negative; but Orfila declared that it was possible, for that as early as the year 1806, Vauquelin had read at the Institute a *mémoire* on the property chlorine has of giving to black hair all the lighter colours, and even of bleaching it.

This case led to careful experiments by Orfila, and subsequently by Devergie. Orfila examined the mode of turning the hair from light to dark, from dark to light, and from light red or chestnut to other shades of colour. Devergie limited himself to the verification of Orfila's experiments on the effect of chlorine.

1. The following are modes of changing the hair from light to dark, with simple rules for detecting the fraud.

a. Charcoal and grease.—This is easily detected by the soiling of the fingers; and by placing a lock of the hair in hot water, when the grease swims, and the charcoal falls to the bottom.

b. Salts of bismuth, lead, and silver.—The hair, previously freed from its oil by liquor ammoniæ, is moistened with a solution of one or other of these salts, and then for a quarter of an hour with sulphuretted hydrogen water. The black sulphides thus formed may be detected by steeping a lock of the hair in dilute nitric acid, and testing for the base. More than one of the processes used by the photographer would effect the same change.

A mixture of litharge, chalk, and lime, in nearly equal proportions, dissolved in water, was found very effectual. The hair was kept moist with it for three or four hours, and then allowed to dry. The chalk and oxide of lead were next removed with dilute acetic acid, and, lastly, the hair was rubbed with yelk of egg. The colour of the hair was thus effectually changed without

injury to its texture. These ingredients, in proportions varying according to the degree of change required, compose the *Tinctura Pompeiana* of the shops. By steeping a lock of the hair in dilute nitric acid, the ingredients of this mixture are dissolved with effervescence, leaving the nitrates of lead and lime in solution.

2. Mode of changing the hair from dark to light.

The results of numerous experiments made by Orfila and Devergie with solutions of chlorine of different strengths, may be thus summed up. Black hair may be changed to various lighter shades, as dark and light chestnut, dark and light blond, yellow, and yellowish white, by being steeped or washed a longer or shorter time in solutions of chlorine of different strengths. But Orfila erred in supposing that the marked effects produced by soaking the hair in a solution of chlorine could be obtained by merely combing it with that fluid, for hair so treated is but slightly changed even after many repetitions of the process. The chlorine is readily detected by its odour, even after washing the hair as many as fifty times with water; the colour of the hair is peculiar, by no means uniform, and not easily confounded with any natural colour; and the hair itself is hard, stiff, and brittle. (These results are in strict accordance with those of my own experiments)—(G.). Better results are obtained with nitric and nitro-muriatic acid, which, diluted with 50 times their bulk of water, impart a golden tinge to dark hair, without apparently injuring its texture. Peroxide of hydrogen is now largely employed by hair-dressers for this purpose. All these processes occupy some time; and the fraud is easily detected by chemical tests, or by allowing the hair to grow, or even by stripping the person, and comparing the hair of the head with that of the covered parts.

The hair undergoes a marked change of colour in the course of some processes of manufacture. In turning rollers, for instance, out of the wood known as "green ebony," light hair assumes a green tint. A similar change results from working in an atmosphere containing finely-divided copper.

The effect of the sudden and violent emotions of fright and grief in turning the hair grey is well known; and a like change may also be produced by disease and other obscure causes. In a case related by Dr. Gordon Smith a complete change of colour in the hair of the whole body took place in a girl thirteen years of age in a single night, without previous indisposition or emotion. Such changes are sometimes permanent, but in other cases the colour of the hair has been restored. When the loss of colour affects the hair of the head, it is sometimes limited to certain portions only.

One other question relating to the identity of the Living remains to be examined, viz., *What degree and duration of light are necessary to enable an observer to distinguish the features, so that the person may be afterwards identified?* That a very short duration of a brilliant light suffices for this purpose is shown by the following case:—A lady, on her way from India, awoke in the middle of a dark night, and heard some one stirring in her cabin. A sudden flash of lightning enabled her to see distinctly a man rummaging one of her trunks, and so to discern his features as to identify him next morning. Some of the stolen things were found upon him, and he acknowledged the fact.*

In the following case, the question arose whether the light caused by the flash of a pistol would suffice to discover the face of the person firing.

The Sieur Labbe, on a dark night in May, 1808, was riding with the widow Beaujean, attended by a servant on foot. The servant was wounded in the hand by a gun fired through a hedge bordered by a ditch; and both he and his master swore that they recognised the assassin by the light of the discharge. An accused party who was arrested, tried, and condemned to death, appealed to the Court of Cassation; and Gineau, Member of the Institute, and Professor of Experimental Physics in the Imperial College of France, was consulted as to the possibility of identification in the manner described. Accordingly, Gineau, his son, Professors Dupuis and Caussin, and others, stationed at different distances, to witness the effect, caused several primings to be fired in a dark room. The light though strong, but fuliginous, was so transient that "it was scarcely possible to see distinctly the form of a head, and that of the face could not be recognised." The experiments were then repeated in the court-yard of the college, the gun being loaded with powder, but with the same results. The sentence was reversed.†

These experiments did not convince Foderé, who thought that if the night were dark, and the persons within six, eight, or ten feet of each other, identification was possible: and the results are certainly at variance with the opinions of persons accustomed to the use of fire-arms, as well as with our own experiments. We repeatedly recognised the face of a friend by the discharge, in the dark, of a gun close at hand (G.). It may also be reasonably contended, that under strong excitement, when the perceptions are acute, as the actions are rapid, a person exposed to danger might have a quicker and more distinct perception than an ex-

* Montgomery: 'Cyclopædia of Pract. Med.,' art. Identity.
† Quoted by Beck from the 'Causes Célèbres.'

perimenter. The question, then, is one which admits of satisfactory solution only by collecting cases of this class.

The following case occurred in England in 1799. One Haines was indicted for shooting at Edwards, Jones, and Dowson, Bow Street officers, on the highway. Edwards deposed that, in consequence of several robberies near Hounslow, he, with Jones and Dowson, set off in a post-chaise one dark night in November, and were attacked near Bedfont by two persons on horseback, one of whom stationed himself at the horses' heads, and the other at the door of the chaise. By the flash of the pistols he could distinctly see that the man at the chaise-door rode a dark-brown horse, between thirteen and fourteen hands high, of a very remarkable shape, having a square head, and very thick shoulders, and altogether such that he could pick it out of fifty horses: he had since recognised it. He also perceived by the same flash of light that the man had on a rough shag-brown greatcoat.*

A few similar cases have occurred in England; and there is a French case to the same effect in the Introduction to Foderé's 'Treatise' (note p. 28).

II. IDENTITY OF THE DEAD.

After death by accident or violence, and in cases of exhumation, the medical man may be called upon to assist in identifying the entire body; to reconstruct one that has been cut to pieces, and the parts scattered; or to examine a skeleton or parts of it, in order to determine the sex, age, and probably stature of the person to whom it belongs.

By careful examination he may ascertain the sex, form some judgment of the age, and even guess at the trade or occupation by the muscular development, the skin of the palms of the hands and the nails (indicating hard work, or the reverse), and the presence or absence of tattooing so common in soldiers, sailors, and the idler classes, so rare in others. Stains on the hands or clothes may also help to determine the employment.†

The following are examples of successful identification:—

Dupuytren identified a murdered man chiefly by a malformation of the hip-joint; and by a like deformity MM. Laurent, Noble, and Vitry a corpse buried in a cellar at Versailles three years. The body of Maria Martin was identified eleven months after her death by the absence of certain teeth from the upper

* Montgomery: 'Cyclop. of Pract. Med.,' art. Identity.

† See this subject treated in detail in the Manuals of Briand and Chaudé. 7th edition, p. 553.

and lower jaw, and by signs of inflammation, with extensive adhesions of the pleura, answering to an attack of inflammation of the chest, from which she was proved to have suffered shortly before her mysterious disappearance. A doubtful case, tried at Edinburgh, was decided by a dentist, who produced a cast of the gums. The scanty remains of the body of the Marchioness of Salisbury, discovered in the ruins of Hatfield House, were also identified by the jaw-bone having gold appendages for artificial teeth; and the identification of the body of Dr. Parkman (*see* p. 32) was assisted by the very peculiar formation of the jaw, and the correspondence of part of it with a cast taken by a dentist.

In some remarkable instances an imperfect sort of identification has been effected after long interment. The real burial-place of some distinguished person has become a matter of dispute, and a coffin such as was likely to have been used, has been discovered containing the remains of some body. In such cases, when the interment took place several centuries before in a leaden coffin or wrapper, the soft parts, though retaining their form at the moment of exposure, disappear at once as a fine dust. But when the interment is more recent, the body may be completely identified. The finding of the remains of Henry IV. in Canterbury Cathedral, after the lapse of nearly four centuries and a half,* is an example of the first class of cases; the identification of the remains of Charles I., after 165, and of the patriot Hampden, after 185 years, of the second class.† The face, notwithstanding its disfigurement, bore a striking resemblance to the portrait of the king on coins, busts, and paintings, and the fourth cervical vertebra was found smoothly divided transversely. As this case is an excellent illustration of the condition, after 165 years, of a body suddenly deprived of life, embalmed and interred in lead, the following brief particulars are added:—On removing part of the lead coffin an inner coffin of wood much decayed was exposed, and within this the body wrapped in cere-cloth, into the folds of which an unctuous matter, mixed with resin, had been poured, so as to exclude the air. The coffin was quite full, and on removing the covering from the face, the skin was found dark and discoloured, the forehead and temples well preserved, the cartilage of the nose gone, the characteristic pointed beard perfect, the left ear entire, and the left eye open and full, though it

* See Felix Summerly's 'Handbook for Canterbury.'

† 'An account of the opening of the Tomb of Charles I.' in Sir Henry Halford's 'Essays and Orations.' The bodies of William Rufus, Henry I., Richard I., King John, and Edward I., have at different times been more or less completely identified.

vanished on exposure. The head was found loose, and was easily taken out and held to view. It was heavy and wet, with a liquid that gave to writing-paper and linen a greenish-red tinge. The textures of the neck were solid, and the back of the scalp was perfect and of a remarkably fresh appearance. The hair of the head was a beautiful dark brown, that of the beard of a redder tint. The divided muscles of the neck were considerably retracted, and the smooth surface of the divided fourth vertebra was visible.

Fig. 1.

A reduced copy of the engraving which accompanies the description is annexed.

In the same vault in which Charles I. was interred, Henry VIII. had been deposited. The leaden coffin, enclosed in a thick elm case, appeared to have been beaten in so as to leave an opening large enough to expose a mere skeleton of the king, with some beard upon the chin. The body had then been interred 266 years.

The search for the body of Hampden was made on the 21st of July, 1828, in the presence of Lord Nugent and others, in Hampden Church, Bucks. The coffin plate being corroded, the coffin selected for examination was assumed to be his in consequence of its position near the tablet erected to his wife. It was a lead coffin, enclosing two wooden ones, of which the inner one was filled with sawdust. The body was tightly wrapped in three layers of cloth. The abdomen had fallen in. The face, which was white, and marbled with blood-vessels, showed the upper part of the bridge of the nose, eyes but slightly sunk, auburn hair six inches long, strong whiskers, and some beard. The upper teeth were perfect, and those that remained in the lower jaw sound. The skull was well formed, and the forehead broad and high. The upper extremities were muscular, the left perfect, but the right hand was detached, the bones of the arm having been sawn through. Several small bones of the hand, but no finger nails, were found in a separate cloth. The nails of the left hand were entire. The left shoulder was entire, and the socket of the joint white; but the socket of the right shoulder was of a

brownish tint, and the clavicle hung loose and detached from the scapula. The body was 5 feet 9 inches in height, strongly built, and muscular. The exhumation confirmed the account of Hampden's death as given by Sir Robert Pye, who married Hampden's eldest daughter, and, at the same time, went some way to explain Lord Clarendon's account of the shattered shoulder as the true cause of death. The dislocated shoulder was probably caused by a fall from his horse.*

A quite recent and most interesting case of identification is that of the great traveller, Livingstone—an ununited fracture of the humerus, the result of the bite of a lion, was sufficient identification in the case of the body of a European brought from the interior of Africa. Coincidence was here quite out of the question.

It should be borne in mind that identification after these long periods of time is only rendered possible by the exclusion of the air by close-fitting wrappers and sealed coffins. How the work of identification is interfered with by the march of putrefaction under ordinary circumstances of interment, and how it may be exceptionally assisted by conversion of the body into adipocere, will be shown when treating of *Putrefaction*.

To the preservation of the bones it is impossible to set any limit of time. Those of King Dagobert, disinterred from the Church of St. Denis, after 1200 years, others from Pompeii after 1800, and others, as parts of Egyptian mummies full 2000 years old, attest their permanence. There is, therefore, no medico-legal case in which they would not be found in a state fit for examination.

The cases of mistaken identity in the living have their parallels in the dead, as the following case will show :—

A resurrection-man was tried for raising the body of a young woman from the churchyard of Stirling, nine weeks after death. It was identified by all the relations not only by the features, but by the left leg being shorter than the right. The jury was convinced that the *libel was proven*, and gave a verdict accordingly. "Now I am certain that this was not the body of the woman who was taken from the churchyard of Stirling, but one that, at least six weeks after the time libelled, was buried in the churchyard of Falkirk, from which she was taken by this man, who also took the other for which he was tried; she also was lame of the left leg: thus, though guilty of the offence laid to his

* 'Annual Register' for 1828, Chronicle p. 93.

charge, he was found guilty by a mistake of the *corpus delicti*."—(Dunlop, note to Beck's 'Medical Jurisprudence.')

Cases illustrative of the possibility of dead persons being mistaken for living ones, not merely by acquaintances and friends, but by parents and near relations, are recorded by Smith, and by Dr. Cummin, in his lectures. ('Medical Gazette,' vol. xix.)

Calculation of Stature.—If we are dealing with an entire skeleton, we may calculate the stature of the person to whom it belonged by adding about an inch-and-a-half for the soft parts. If the bones are detached, they should be laid out as nearly as possible in the natural position, and then measured, making allowance, as above, for the soft parts.

It is commonly stated that, when the arms are stretched out horizontally, the line from one middle finger to the other is equal to the height. This, though not exactly true (and less true in women than in men), may be used to determine roughly the stature of a body when only the bones of an arm are forthcoming. By doubling the length of the arm, and adding twelve inches for the clavicles and an inch-and-a-half for the sternum, as suggested by Dr. Taylor, a guess may be made at the stature.

M. Sue, more than a century ago, collected data for calculating the stature from the length of the extremities.* He measured subjects of medium height, chosen as well proportioned. His measurements, reduced to English feet, inches, and lines, are given in the following table: the first three lines of which show the results of one measurement; the last two of averages:—

Age.	Body.	Trunk.	Upper Extremity.	Lower Extremity.
	Ft. In. Lin.	Ft. In. Lin.	Ft. In. Lin.	Ft. In. Lin.
1 year . .	2 0 0	1 2 5	0 9 7	0 9 7
3 years . .	2 11 3	1 8 4	1 3 0	1 3 0
10 years . .	3 1 0	2 1 7	1 8 4	1 9 11
14 years . .	4 10 8	2 5 11	2 4 1	2 4 10
20-25 years .	5 8 2	2 10 1	2 8 0	2 10 1

According to M. Sue, towards the 20th, and from that to the 25th year, the upper border of the symphysis pubis forms the

* 'Sur les Proportions du Squelette de l'Homme.' Mémoires présentés à l'Académie Royale des Sciences, tom. ii. 1755.

exact centre of the body, and so continues till in old age the spine becomes curved. Before twenty, the centre of the body varies according to the age.

But Orfila, by measurements both of the subject and the skeleton,* showed that these statements of M. Sue must be received with caution. Thus of 44 males (with 4 exceptions adults), only 7 had the length from the vertex to the pubes exactly equal to that from the pubes to the sole of the foot; while in 23 instances, the former measurement exceeded the latter; and in 14 fell short of it. The greatest difference on either side was $2\frac{1}{3}$ inches English. Again, in not one out of 7 females were the above measurements equal: the upper half of the body was longest in 6, shortest in one. The males on an average were longer from the vertex to the pubes by more than $\frac{1}{3}$ inch, the females by $1\frac{1}{6}$ inch.

On examining the tables more closely, and bringing together the instances in which the length from the vertex to the pubes happens to be the same, we have found a considerable difference in the length from the pubes to the sole. Of fifteen males measuring 2 feet 9 or 2 feet $9\frac{1}{3}$ inches from the vertex to the pubes, one measured as little as 2 feet 7 inches from the pubes to the sole, while another measured 2 feet $11\frac{1}{2}$—a difference of $4\frac{1}{2}$ inches. Again, of five females, in whom the upper measurement was 2 feet $6\frac{3}{4}$ to 2 feet 7 inches, one measured little more than 2 feet 4, the other little less than 2 feet 8—a difference of nearly 4 inches.

So that in using Orfila's measurements, we might be in error to the extent of 4 to $4\frac{1}{2}$ inches. His measurements of the skeleton exhibit deviations still more remarkable; for in one instance in which the upper part of the body measures 3 feet $1\frac{1}{3}$, the lower part measures only 2 feet 8—a difference of $5\frac{1}{3}$ inches; and, in another, in which the upper measurement is 2 feet $5\frac{1}{2}$, the lower measurement is 2 feet $11\frac{1}{2}$—a difference in the opposite direction of 6 inches.

It follows, then, that M. Sue's facts are too few, and his statements too general; and that even the more numerous and exact measurements of Orfila, if used to determine the stature, might lead to very serious error.

Orfila's measurements of the cylindrical bones, which he used to calculate the stature of the skeleton and of the living body, also yield, as the subjoined tables show, very unsatisfactory results:—

* 'Traité de Médecine Légale,' tom. i. p. 105.

Stature of the Skeleton calculated from the Length of the Cylindrical Bones.—(Orfila's second table.)

LENGTH OF BONE.				STATURE.							
				Max.			Min.			Difference.	
	Ft.	In.	Lin.	Ft.	In.	Lin.	Ft.	In.	Lin.	In.	Lin.
Humerus (6 obs.)	1	1	0	6	1	3	5	9	9	3	6
Ulna 7 ,,	0	10	8	6	1	3	5	5	0	8	3
Femur 7 ,,	1	6	1	6	0	0	5	7	0	5	0
Tibia 7 ,,	1	3	0	5	10	6	5	5	0	5	6

So that for the same length of cylindrical bone we may have a stature of from three and a half to eight and a quarter inches.

Stature of the Body, calculated from the same data. (Orfila's first table.)

LENGTH OF BONE.				STATURE.							
				Max.			Min.			Difference.	
	Ft.	In.	Lin.	Ft.	In.	Lin.	Ft.	In.	Lin.	In.	Lin.
Humerus(19obs.)	1	2	6	5	8	1	5	4	6	3	7
Ulna 14 ,,	0	10	8	5	10	10	5	5	8	5	2
Femur 12 ,,	1	5	9	5	9	8	5	4	6	5	2
Tibia 11 ,,	1	2	5	5	9	8	5	4	6	5	2

Here, then, for the same length of cylindrical bone, we have a variation in stature of from more than three and a half to more than five inches.

This minute analysis of Orfila's tables is rendered necessary by the undue importance he himself attached to them; for he says, "we are certain that it will be possible in the greater number of cases, on consulting these tables, and on having regard especially to the lengths of the femur and humerus, to arrive sufficiently near the truth." This false confidence arose from his not having properly tested his own figures—an omission the more to be regretted, as his tables have been used for practical purposes. Thus, Dr. Henri Bayard, in three instances, in which the only parts of the body left were the bones, applied Orfila's data; in two unsuccessfully, but, in the third, with a success which is obviously attributable to a coincidence.

The following table shows the average measurements in English feet, inches, and lines, obtained from 44 male and 7 female subjects.

	Stature.	Vertex to Pubes.	Pubes to Foot.	Upper Extremity from Acromion.	Femur.	Tibia.	Fibula.	Humerus.	Radius.	Ulna.
Male .	5 8 6	2 9 6	2 8 0	2 5 6	1 5 8	1 2 7	1 2 2	1 0 5	0 9 5	0 10 2
Female	5 1 0	2 7 1	2 5 11	2 2 6	1 4 6	1 1 9	1 1 5	0 11 7	0 8 8	0 9 9

It is obvious from the foregoing statements that the estimation of stature from parts of the body or skeleton is much less easy than the French authorities have represented it to be. (G.)

AGE.

The law defines, with much minuteness the privileges, immunities, and responsibilities that belong to the several periods of life. It rarely happens, however, that the medical man is required to give evidence on this point; and the occasions for so doing will become less numerous as our registration of births becomes more complete.

It is chiefly as a preliminary to complete personal identification that the question of age is important, and, like the general question, it divides itself into two parts. 1, *The Age of the Living;* and 2, *The Age of the Dead.*

1. AGE OF THE LIVING.

Human life has been arbitrarily divided into septennial and decennial periods, and certain ages (the climacterics) have been specified as epochs of unusual importance and danger. These divisions and distinctions are wanting in the precision necessary for medico-legal purposes. Nor do the averages of Quetelet based on the ascertained stature and weight of the body at different ages, admit of application to individuals, and the same objection applies to the position of the centre of the body as a test of age; for though it may be stated, in general terms, that at birth it is at the navel; in the adult, at the pubes; for intermediate ages, at intermediate points, nearer to the navel in the infant, and to the pubes in those approaching adult age; this statement is inexact, and especially in women, in whom the thigh

bones being shorter, and the trunk longer, than in men, the centre of the body is above the pubes.

The facts relating to the period of puberty in the two sexes, and of change of life in women, also show the little dependence to be placed on these occurrences as indications of age. The extremes are so far apart that the averages cannot be safely applied to individual cases.

We have more precise, though still very imperfect, means of fixing the age of younger persons, in the successive appearance of the teeth both of the first and second dentition.

The first set or milk-teeth appear in the following order :—

Central incisors	5— 7 months
Lateral incisors	6— 9 „
First molars	8—15 „
Canine teeth	15—18 „
Second Molars	18—24 „

The milk-teeth, then, do not appear at the same age in all infants; while some are born with the incisors above the gums; others have no teeth till the end of the second year; and a few even live several years without a single visible tooth.

The order and probable time of appearance of the permanent set, with the number of teeth existing at each age, is shown in the annexed table.

AGE.	INCISORS.		Cuspids.	BICUSPIDS.		MOLARS.		
	Central.	Lateral.		Anter.	Poster.	Anter.	Second.	Poster.
7 years.	...	...	...	...	...	4	...	...
8 years.	4	...	...	...	...	4	...	...
9 years.	4	4	...	...	...	4	...	...
10 years.	4	4	...	4	...	4	...	...
11 years.	4	4	...	4	4	4	...	...
12—12½.	4	4	4	4	4	4	...	...
12½—14.	4	4	4	4	4	4	4	...
18 —25.	4	4	4	4	4	4	4	4

As it was thought that the facts of this table might be employed as a standard of comparison in determining the age of children, especially of those employed in factories, Mr. Saunders*

* 'The Teeth a Test of Age.' By Edwin Saunders.

selecting the two periods of 9 and 13 years, observed the number of teeth existing at those periods in many hundred children, and obtained the following results:—

Of 457 boys 9 *years of age*, 219, or nearly one-half, had the number of teeth stated in the table; namely, 4 central incisors, 4 lateral incisors, and 4 anterior molars. Of 251 girls, of the same age, 168, or much more than one-half, had the same number. Taking the two sexes together, 387 out of 708 had the full complement of teeth. The remainder in both sexes consisted of children who, in place of 4 of each kind, had a smaller number of one or the other. In a large proportion of the children, one, two, or three of the four lateral incisors were wanting, and so of the other teeth; and in 52 cases only the lateral incisors were absent.

If then, in the columns of the table, opposite the age of 9 years, we substitute for 4, the numbers 1, 2, 3, or 4, and assert that wherever any of these numbers are found, the child is in its 9th year, our assertion will be borne out in 656 out of 708 cases, or about 13 in 14. In the remaining 52, a child of eight might be mistaken of one of nine years.

The inquiry respecting children who had attained the age of 13, gave the following results:—

Rather less than half the boys, and more than half the girls, and as nearly as possible half of the two sexes taken together, had the full complement of teeth entered in the table as belonging to children of 12½ to 14: by far the majority of both sexes had one or more of the several orders of teeth: and in 11 instances only were some or other of the teeth wholly wanting. In three cases a child of 13 might have been mistaken for one of 12 to 12½; in one for one of 11, and in another for one of 10. In a vast majority of instances, however, a child having one or more of the several teeth indicated in the columns of the table opposite 12½ to 14 years had completed its 13th year.*

The permanent teeth are not complete till the *dentes sapientiæ* make their appearance. This usually happens from the 18th to the 25th year, but sometimes much later; and a case is recorded by Dr. Hamilton of a man of 80 who died from the irritation produced by cutting a wisdom-tooth.

Some stress has been laid as a test of age, on the white line at the margin of the cornea, known as the *arcus senilis*. As the arcus is occasioned by a deposit of oil-globules, which may take place from causes other than advancing age; as Mr. Canton

* The results here stated in general terms were given in the first edition of this work in a tabular form.

reports cases of his own, or on the authority of others, in which it has been present at 42, 34, 33, and even 28 years; and as we have ourselves seen it completely formed at 42 and 39, and absent at 79 and 85, it is obvious that this appearance must either be rejected as a test of age, or only used in healthy persons living or dead, in conjunction with other signs of age. (G.)*

All other indications of age in the Living, such as grayness or baldness of the hair, and loss of teeth, are deceptive. Cases of premature old age, of unusual vigour at advanced periods of life, and of restoration to the aged of some of the structures and functions proper to an earlier period (*e.g.* the cutting of teeth and the growth of coloured hair; the secretion of milk, and the persistence or return of the menstrual discharge), may prevent us from even guessing at the age. On the other hand, the early occurrence of the marks of puberty in both sexes, and the premature or very late appearance of the menses in the female, create difficulties in rightly estimating the age at earlier periods.

II. AGE OF THE DEAD.

In the bodies of persons recently dead, we have the same means of estimating the age as in the living; and we may learn something from the dissection of the body. Bony deposits in the heart and arteries, for instance, afford a strong probability that the subject had reached a mature if not an advanced period of life.

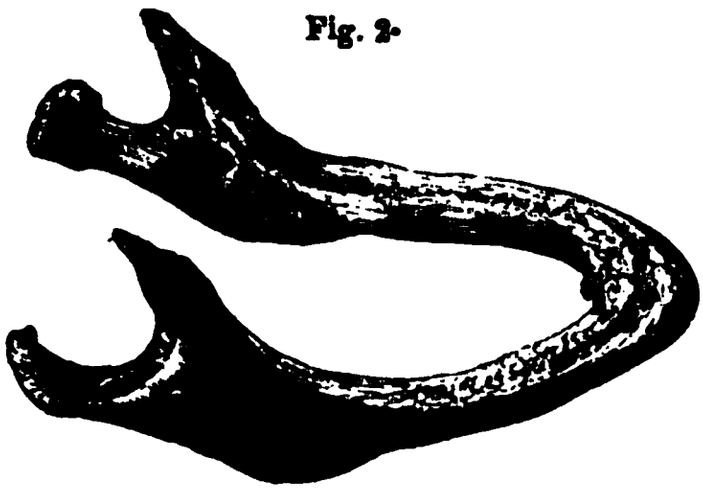
The state of the bones also furnishes some clue to age, both in young and old. Up to the age of 25 the progress of ossification in the long bones affords the readiest clue to the age. The head and tuberosities of the *humerus* blend about the age of 5, and are completely united to the shaft about the age of 20. The condyles unite with the shaft at from 16 to 18. The head and trochanters of the *femur* blend with the shaft at about the age of 18, and the condyles with the shaft at about 20. About the age of 30, it is more difficult to determine the age. As, however, age advances certain other changes occur. The cartilages of the ribs become ossified by degrees, and earlier in men than in women. In advanced age the cartilages of the larynx are converted into bone. The sutures of the skull gradually become less distinct as life advances. The frontal suture disappears about the age of puberty. If the other sutures have grown indistinct, we may assume that the age was not under 50. In advanced age the

* On the Arcus senilis, or fatty degeneration of the Cornea. By Edwin Canton, F.R.C.S.; 'Lancet,' May 11, 1851.

intervertebral discs shrivel, the spine bends forward, and the bodies of the vertebræ become bevelled off in front, the bones in general lose weight, and those of the skull become thinner through the disappearance of the diploe.

But the *jaw* is the part which undergoes the most marked changes with age. In the fœtus and in early infancy the ramus and body form a very obtuse angle. In middle life they form nearly a right angle; but in old age, when the teeth have dropped out, the alveolar border is absorbed, and the jaw reverts to the infantile type. In very old persons the jaw has the characteristic appearance shown in the annexed engraving:—

Fig. 2.



SEX.

This subject, like the foregoing, divides itself into two parts. 1. *The Sex of the Living*; and 2, *The Sex of the Dead.*

I. SEX OF THE LIVING—DOUBTFUL SEX.

The question of sex may be raised in reference both to infants and adults. In the case of a new-born child the issue of parents possessed of real or landed property, the right of succession, and should it die, the disposal of the property depends on the sex. If a wife, being tenant in tail-male, is delivered of a son born alive, the husband's right is secured; but the property passes from him if she gives birth to a daughter. This form of succession is termed *tenancy by the curtesy.*

It may be necessary also not merely to ascertain the sex, where that can be done, but in doubtful cases, to determine which sex predominates; for it appears, on the authority of Coke upon Littleton, that "an hermaphrodite, which is also called Androgynous, shall be heire, either as male or female, according to that

kind of the sexe which doth prevail, and accordingly it ought to be baptized."

The question of sex may also arise at a later period, as in the case quoted by Beck of a young nobleman of doubtful sex, whose parents consulted a medical man whether the education should be that of male or female.

There are three conditions of the organs of generation which may present difficulties to the medical examiner.

1. The organs of a male may resemble those of the female.
2. The organs of a female may resemble those of the male.
3. The organs of the two sexes may be blended.

1. The organs of a male may resemble those of the female. (Androgyni.) The most common malformation of this sort consists of a small, imperfect, and imperforate penis, a short canal beneath it, and a cleft scrotum, bearing respectively some resemblance to the clitoris, vagina, and labia of the female. Each section of the scrotum may contain a testicle, but the testes, one or both, may be lodged behind the external ring. The short canal, or *cul de sac*, which replaces the urethra and opens at the base of the penis, or in the perineum, near the anus, is found to communicate with the bladder. It is often enlarged at its commencement, so as to resemble the vagina; and has been even made to discharge its sexual function. From the position of the opening of the urethra beneath the imperforate penis, these persons are called *hypospadians*.

The presence of testicles in the folds resembling the labia, or in the groin; the communication of the opening beneath the imperforate penis, or in the perineum, with the bladder; the absence of any organ corresponding to the uterus; and, in the adult, the absence of menstruation—enable us at once to determine the sex. In most of these cases the build of the body, the muscular development, the voice, the tastes and habits, are more those of a man than of a woman. Many cases answering to this description are on record; and there are preparations, casts, models, and drawings, illustrating these malformations in most of our museums. The following case by Mr. W. Loney ('Lancet,' May 7, 1856) is a good illustration:—Jane W——, a lunatic, twenty-eight years of age, was admitted into the Macclesfield workhouse. She excited suspicion by her unwillingness to be washed, and on being examined, was found to have a penis two inches long, and the same in circumference, placed on the pubes, just above and between the external labia; with a well-defined prepuce, which could be moved at pleasure, causing a slight erection. Just below this was an opening so small as scarcely to admit the little finger,

and a ligamentous band could be felt at about three inches distance from its mouth. The urethra could not be seen, but a catheter was passed into the bladder through this opening. The penis was imperforate. The hair of the head was short and curly, like a man's; the limbs very muscular and hairy; and the voice exceedingly rough and masculine. The mammæ were entirely absent, and there was more hair than usual about the pubes. She had never menstruated. Her taste was so depraved that she would eat old poultices with great delight. She was strong and healthy, and annoyed the young women in the same ward by the display of her amatory propensities. But there are cases in which an enlargement of the breasts, coupled with a preference for the society of the male, might mislead if the organs of generation were not examined; and in some instances the absence of the sexual passion creates uncertainty.

Sometimes the penis, well or ill-formed, is confined to the scrotum by a peculiar formation of the integuments. This malformation, with the other deviations from the normal structure just described, occurred in two cases, one a negro, the other a European, of which Cheselden gives engravings; and in the case of a child baptized and brought up as a girl, Mr. Brand by a slight incision liberated the restricted parts, and proved to the parents that they had been mistaken.

Another malformation belonging to this division, which might possibly give rise to doubt, consists in a deficiency of the anterior wall of the urinary bladder, and of the corresponding part of the abdominal walls, their place being occupied by an irregular red and sensitive mass, with the ureters opening upon it. The penis is short, imperfect, and imperforate, and the vesiculæ seminales open in a small tubercle at its root, or on the red and sensitive surface. The testicles are generally well formed, sometimes contained in the scrotum, sometimes to be felt in the groin, or they have not descended. The sexual appetite may be strong, weak, or altogether wanting. Those who have this malformation are called *epispadians*.

2. The female organs may resemble the male. (Androgynæ.) The malformations belonging to this class are an enlarged clitoris, and a prolapsus uteri. In the first case—that of enlarged clitoris—the absence of testicles from the labia, the presence of a vagina and uterus, the occurrence of menstruation—these singly or combined, render the distinction easy.*

Sir Everard Home mentions an instance in a Frenchwoman

* For cases illustrative of this malformation consult the 'Cyc. of Anatomy and Physiology,' art. Hermaphroditism.

having a prolapsus evident on inspection, who laid claim to the male sex, and was shown as a curiosity. And of the second form of malformation Mahon relates the case of one Margaret Malaure, exhibited at Paris in 1693, dressed as a man, and alleging that she possessed and could use the organs of both sexes. Several physicians and surgeons certified that she was an hermaphrodite; but Saviard, an eminent surgeon, being incredulous, examined her in the presence of his brother practitioners, and found a prolapsus uteri, which he reduced.

3. The organs of the two sexes may be blended.

Many cases of this imperfect approach to the true hermaphrodite are on record. In some an ovary has been found on the left side, and a testis on the right; in others the position of these organs has been reversed; and in a third class of cases the external organs have approximated closely to the female type, and the internal to the male, or the reverse.* But no case of real hermaphroditism, the organs of the two sexes being perfectly developed in the same person, is on record.

In examining cases of doubtful sex, the following points should be attended to:—The size of the organ corresponding to the penis or clitoris, and whether it is perforate or imperforate; the form and mode of attachment of the prepuce; the presence or absence of parts corresponding to the nymphæ; the presence or absence of testicles. The openings that exist must be carefully examined with a sound, to ascertain whether they communicate with the bladder or uterus, or are merely *culs de sac;* and inquiry should be made respecting the existence of the menstrual discharge, or of vicarious discharges. The general conformation and appearance of the body should also be observed, including the growth of the beard,† and of hair on different parts of the body; the formation of the shoulders and hips; the development of the breasts; the fulness of the thighs; the tone of the voice; and the feeling and conduct towards either sex.

II. SEX OF THE DEAD.

When the entire body is submitted to inspection, there

* See the case of Durrje or Derrier in Cummin's Lectures, 'Med. Gaz.' vol. xix.: and for cases of the last-named malformation, occurring both in man and animals, the very complete and learned paper on Hermaphroditism in the 'Cyclopædia of Anatomy and Physiology.'

† The curious case given by Dr. Chowne of an otherwise well-developed female with copious beard and whiskers, cautions us not to attach too much importance to any single sign detailed in the text. For the case itself, and a learned history of similar instances, see 'Lancet,' 1852, vol. i. p. 421.

should be no difficulty in determining the sex, except in those rare instances in which the characters of the two sexes are blended; and in these, the sex, which could not be determined during life, may be ascertained by dissection.

But when the question of sex is raised after death, it is generally in reference to the skeleton, or some part of the osseous system, in which the following differences are observable:—

The *bones* of the female are lighter, more cellular, smoother, and less curved, than those of the male: the processes less marked, and the joints smaller. The *skull* of the female is smaller, more ovoid, more bulging at the sides, and longer behind the foramen magnum; the face more oval, the frontal sinuses less strongly marked, the nostrils more delicate, the jaws and teeth smaller, and the chin less prominent. The *chest* of the female is deeper than that of the male; the sternum shorter and more convex; the ensiform cartilage thinner, and ossified later in life; the ribs smaller, and the cartilages longer. The *vertebral column* is longer, and the bodies of the vertebræ are deeper in the female than in the male. The *pelvis*, however, presents the most striking contrast. The ilia are more expanded and horizontal in the female; the sacrum more concave; the pubes more shallow; the angle formed by the descending rami more obtuse; the pubic arch wider, the tuberosities of the ischia more largely separated; the foramen ovale larger, more triangular, and more oblique; the acetabula wider apart; the entire pelvis more shallow, but larger in its outlets than in the male. These differences are shown in the annexed engravings, in which A represents the male, and B the female pelvis.

The difference between the male and female skeleton is less strongly marked before the age of puberty.

Fig. 3.

The following table shows the respective measurements of the male and female pelvis at the brim :—

	Male.	Female.
Antero-posterior, or conjugate diameter	4 in.	4½ in.
Transverse	4½ „	5¼ „
Oblique	4¼ „	5 „

(Quain and Sharpey.)

This group of subjects—identity, age, and sex—may be advantageously brought to a close by three cases, one in the living, and two in the dead, in one or other of which the question of identity, in most of the forms it is likely to assume, will receive ample illustration. The Tichborne case, which would have formed a fitting pendent to that of Martin Guerre, will be found at length in an appendix.

1. *The case of Martin Guerre.*—More than three centuries ago (in 1539) a marriage took place at Artigues, in Languedoc, between two children about 11 years old. The husband was one Martin Guerre, the wife one Bertrande de Rois. After the lapse of nine years a son (Sanxi) was born, under peculiar circumstances, known only to the parents. Martin was an elder son, and was settled in the same village with his father. Martin having robbed him of some corn, and fearing detection, disappeared, and was not heard of for eight years. In this interval his father died, leaving four daughters under the guardianship of a younger brother, Pierre. Meanwhile the absent Martin enlisted as a soldier, and had for comrade one Arnauld de Tilh (or Dutille) *alias* Pansette, a man of known bad character, who lived with Martin on such terms of intimacy as enabled him to become possessed of all his secrets. Martin lost a leg in the wars, and being taken ill, and thinking himself about to die, gave Arnauld what he had about his person. At the end of the eight years, this Arnauld, thus possessed of Martin's secrets and personal property, and having been mistaken for Martin by some friends of his, presented himself at Artigues, and was at once accepted as the real Martin Guerre by his uncle, sisters, and all his friends and acquaintance, and, most strange to say, by Bertrande herself, who, having been warmly attached to her husband, welcomed the new-comer with unfeigned affection, and bore him two children, one of whom died young. Arnauld lived with his comrade's wife, and surrounded by his comrade's relatives, friends, and acquaintance, for three years; when a soldier passing through the village, startled Bertrande with the intelligence that her husband Martin,

who had lost a leg in battle, was living in Flanders. Bertrande, disturbed but unconvinced, went to a Notary and bade him draw up a record of the soldier's statements; but she took no further notice of them, and continued to live with Arnauld as before. After three years Pierre, the uncle, quarrelled with Arnauld, and would have killed him but for the interference of Bertrande. Soon after, in consequence of a village quarrel, Arnauld was arrested, and imprisoned at Toulouse, and thereupon the uncle with other relatives tried to persuade Bertrande to denounce him as an impostor; but she resolutely refused, alleging that he must "either be Martin Guerre or the Devil in his skin;" and when he was released on bail, received him as before with every mark of affection. But the next day, the uncle, pretending to act under a power of attorney in Bertrande's name, arrested Arnauld, charging him with fraud and deception. The case was tried at Rieux, the uncle alleging that the prisoner was not Martin Guerre but Arnauld de Tilh, known to many persons in the district from his youth as of bad character. On the part of the prisoner, on the other hand, all the facts connected with his early and complete recognition were adduced, and his perfect knowledge of matters the most trivial and the most secret, backed by Bertrande's upright character, blameless life, and strong affection. Witnesses, 150 in number, were then called, of whom between 30 and 40 had no doubt of the identity of the accused with Martin Guerre, 50 declared him to be Arnauld de Tilh, and 60 said they were so perplexed by the resemblance between the prisoner and Martin, both of whom they had known intimately, that they could come to no conclusion. The son, Sanxi, was then brought forward; and though no resemblance could be traced between him and the prisoner, he was pronounced to have the family look, and to be as like the four sisters of Martin Guerre "as one egg is like another egg." The judge, on summing up the evidence, gave sentence against the prisoner, as an impostor, adulterer, and usurper, and condemned him to be beheaded and quartered. But he appealed to the Parliament of Toulouse, which instituted a new inquiry. The prisoner, on being confronted with Bertrande, said he would abide by her decision, and place his life in her hands. Would she swear that he was not Martin Guerre? Bertrande answered "that she could neither swear nor believe it." Thirty new witnesses were then called, of whom 10 swore that the prisoner was Martin Guerre, 7 that he was Arnauld de Tilh; the rest spoke doubtfully. An uncle of Arnauld and some of his friends said they had recognised the prisoner as Arnauld from the first, but assigned reasons for not having exposed him.

The evidence of the witnesses as to the personal characteristics of the two men led to the conclusion that there was little resemblance between them. Martin was described as tall and dark, spare in body and limb, with his head sunk between the shoulders, a forked curved chin, a hanging lower lip, a large turned-up nose, an ulcer on the face, and a scar on the brow; while Arnauld was short, thick-set, and corpulent, had a stout leg and no stoop, a different set of features, and scars on the face about which the witnesses could not agree. But the prisoner had double eye-teeth in the upper jaw, a scar on the forehead, the nail of the forefinger of the left hand sunk in the flesh, three warts on the right hand and one on the little finger, all which peculiarities were recalled by the witnesses as belonging to Martin Guerre. Martin's shoemaker deposed that his shoes had to be made a fourth longer than those of Arnauld. Martin, too, was a skilled fencer which Arnauld was not, and Arnauld could not speak even a few words of Martin's native Basque language. One witness (Jean Espagnol, an innkeeper) asserted that Arnauld had confided to him in the strictest secrecy all the facts relating to his close intimacy with Martin, and consequent knowledge of all his secrets.

The Parliament of Toulouse found the evidence on the whole so conflicting, attached so much weight to the spontaneous recognition of Arnauld by those who might be presumed to be the best possible judges, and to his admitted resemblance to the four sisters of Martin; while on the other hand, the lapse of time in the case of a lad who left his native village when only 20 years of age, added to the hardships and vicissitudes of a soldier's life, would serve to explain even marked changes in form and face, and the failure to recollect the words of his native tongue, which, indeed, he might have forgotten before he left his native village; all these considerations inclined them to give their sentence in favour of the prisoner. But at this juncture a man with a wooden leg, calling himself Martin Guerre, appeared in court. He was immediately arrested, shut up, and secretly examined; when he displayed the same knowledge of facts respecting his village, acquaintances, and family as Arnauld had done; and when confronted with the prisoner, bore the test of cross-examination equally well, but often answering with less readiness, and even less minuteness of detail. He was then brought face to face with members of the family of Martin Guerre—the brother of Arnauld having absconded and refused to appear. The sisters of Martin Guerre, as they entered one by one, and glanced at the new comer, threw their arms round his neck, burst into tears, called him their real brother, and asked his pardon a thousand times for having allowed themselves to be deceived; and Bertrande,

too, no sooner caught sight of him than she fell on her knees before him, urging in her exculpation of the wrong she had unwittingly done him, the astonishing resemblance between him and the villain who had deceived her, and the readiness with which his own sisters and all the villagers of Artigues had recognised him. The same revulsion of feeling showed itself in succession in all who had borne witness in Arnauld's favour; and the judges, convinced by the tears and passionate grief of the loving wife, reinstated Martin Guerre in all his rights, and condemned Arnauld de Tilh to be hanged and burnt. Before his execution, the impostor made a full confession of his guilt.

2. *Case of Houet.* In the year 1821, Madame Houet, a widow lady, resident at Paris, disappeared; and Bastien, Robert, and Robert's wife, suspected of having made away with her, were tried before the Court of Assize; but for want of evidence, set at liberty. In consequence, however, of information subsequently obtained touching a body said to have been buried about eleven years in a garden, the remains were so completely identified, and the manner of the death so clearly shown, that the prisoners were convicted and punished.

After excavating different parts of the garden, a workman hit upon a hollow spot, which was found to contain the remains of a human body, reduced almost to a skeleton. A drawing was made of the parts *in situ*. The figure lay on the left side, with the head bent on the neck, the vertebral column curved, and the right fore-arm raised, so that the hand nearly touched the face. The pelvis was turned obliquely upwards; the thigh-bones were raised, and the legs crossed beneath them. The prevailing colour of the remains was yellowish-brown, but the parts in contact with some of the long bones were of a deep red tint.

The bones were small and delicate, those of the extremities not curved by muscular motion, and the marks of the insertion of the muscles few and faint. Among the bones of the left hand were found a small gold ring, carved in *facettes;* and several small, well-formed finger-nails. The skull was small and oblong; the sutures well knit; the teeth white and well preserved; but three molars were wanting, and one of the incisors was carious. Some light-coloured hair was found, blended with gray hairs. The ossa innominata were largely spread out; the cavity of the pelvis not deep; the anterior part of the sacrum concave; the sub-pubic holes triangular; the cotyloid cavities wide asunder; and the upper opening of the pelvis had the diameter usual in well-shaped females. It was therefore justly inferred that this was the skeleton of a woman.

The third, fourth, fifth, and sixth cervical vertebræ, and right

clavicle, were held together by a blackish mass, surrounded by several twists of a small decayed cord, leading to the inference that the deceased had been strangled, an inference fully borne out by the circumstantial evidence.

Several elaborate documents were drawn up by the reporters; of the first of which the following is a *résumé*:—

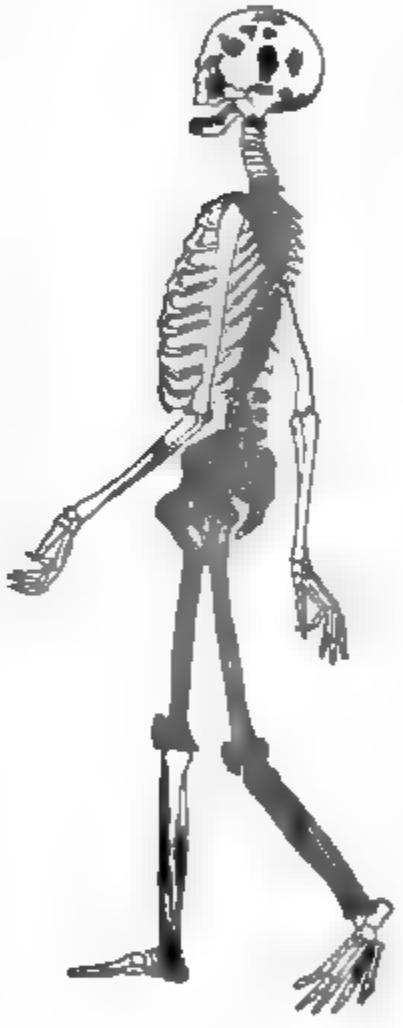
"1. That these bones are those of a *human* skeleton. 2. That the skeleton is that of a *female*. 3. That she had attained the *age* of from 60 to 70. 4. That her stature was about 4 feet 8 or 9 inches. 5. That her hair, which was a bright blond in youth, was mixed with gray at the time of her death. 6. That the hands were small. 7. That during life the bones had never suffered any injury. 8. That this woman died of strangulation, and that the act was, to all appearance, homicidal; and 9. That the body must have lain for several years in the earth."

The prisoners, who had been long suspected, were tried, condemned, and sentenced to forced labour for life.

3. *Case of Dr. Parkman.*—Dr. George Parkman, of Boston, U.S., was last seen alive on the afternoon of Friday, Nov. 23rd, 1849, entering the Medical Institution in which Dr. John W. Webster was Lecturer on Chemistry; and it was proved that he went there by appointment to receive money which Dr. Webster had long owed him. Dr. Parkman was missed, and could not be found; but on the Friday following his disappearance, in consequence of the suspicions aroused against Dr. Webster, search was made in his laboratory and the places attached to it, which issued in the discovery, in the vault of a privy, of a pelvis, right thigh, and left leg, and some towels marked with Dr. Webster's initials, such as he was in the habit of using. There were also found in the furnace of the laboratory, mixed with cinders, many fragments of bone, blocks of mineral teeth, and a quantity of gold. A tea-chest was also found, which contained, embedded in tan, and covered with minerals, the entire trunk of a human body, the left thigh, a hunting-knife, and a piece of twine of the sort used in the laboratory. On the left side of the chest a penetrating wound was discovered; and to this the death was attributed. These portions of a human body being found in a medical college, it might be alleged that they were parts of a dissected subject; but this was shown not to be the case, for the vessels were free from all trace of the preservative fluid always employed in that college. They contained neither arsenic acid, nor chloride of zinc. It was further proved that the joints

had been severed as by a man having some anatomical knowledge, and some practice in dissection. The first step in identification consisted in putting together the fragments of the body. These fitted accurately. The 3rd and 4th lumbar vertebræ coincided, "the right thigh, on being placed in apposition with the pelvic portion, the bones, muscles, and skin, corresponded perfectly;" so also with the left thigh and pelvis; and the left leg and thigh. The fragments, therefore, belonged to the same body; and it was shown that there were no duplicate members or bones. By putting the parts together, and measuring them, they were found to be 57½ inches long; and adding 3 inches for the length from the outer malleolus to the sole of the foot, and 10 inches from the crown of the head to the base of the 6th cervical vertebra, the length was brought up to 70½ inches, the exact stature of Dr. Parkman, as proved by his passport. As to the age of the person to whom th e body belonged, Dr. Stone stated that, judging from the skin, hair and general appearance, the body belonged to a person from 50 to 60 years of age, and that the amount of ossification of the arteries would indicate that he was nearly or quite 60 years old. Dr. Parkman was about 60. The question of sex was not raised, as the parts of generation were found attached to the pelvis. 35 fragments of bone were found, and among these there were 3, which when put together, made up the greater part of the right half of the lower jaw, and the portion thus rebuilt enabled Dr. Wyman to ascertain that the teeth from the coronoid process to the first molar, or bicuspid, were wanting. To obviate this defect, a dentist had been applied to, not long before Dr. Parkman's death, to supply him with

Fig. 4.



mineral teeth. These were found with the *débris* of the bones, in the furnace; and the cast the dentist had taken fitted with great accuracy the very peculiarly shaped jaw of Dr. Parkman.

Thus the identification was complete; and, after a long and patient investigation, Dr. Webster was found guilty, and at length confessed the crime. He first struck Dr. Parkman on the head with a heavy stick, and then stabbed him in the chest.

This short account is taken from a full report published at the time. Dr. Wyman exhibited at the trial a drawing of a skeleton with the bones that were found tinted yellow. In the annexed engraving, taken from p. 54 of the Report, these fragments are printed black. The case affords a good example of the reconstruction of a mutilated body.

CHAPTER II.

IMPOTENCE. RAPE. PREGNANCY. DELIVERY.

The subject of sex having been treated as a means of identification, is here considered in relation to the generative function, and comprises the subjects at the head of the chapter.

IMPOTENCE.

The question of impotence, or incapacity for sexual intercourse, may arise in suits for divorce, in cases of contested legitimacy, and in accusations of rape. The question is not often raised in the case of females, and objection may perhaps be taken to the use of the term impotence in reference to women. But in order to avoid needless multiplication of words, the meaning of the term is here extended so as to embrace both sexes.

Marriage being a contract, presupposes, as do all other contracts, a free exercise of the will, and ability to fulfil its terms.

The first condition comes in question when undue influence has been brought to bear on either party to the contract, and it is alleged that the person so influenced was of weak or unsound intellect. (*See* Unsoundness of Mind, Imbecility, and Dementia.)

The second condition—ability to fulfil the terms of the contract—may fail through physical defects; but in order to establish a legal ground for divorce, corporeal imbecility must have existed *before* the marriage, and be irremediable. The person of the husband may, therefore, have to be examined: but if he is not forthcoming, that of the wife, in order to find confirmation of the alleged impotency. This happened in a case decided adversely to the husband in the ecclesiastical court. A certificate was produced, twelve years after marriage, that the wife was *virgo intacta*, though *apta viro*, and that her health had suffered; the husband had also twice confessed his incapacity, had not given in his answer, had removed into France, and had refused to undergo examination.

Impotence will have to be considered under two heads of—1. Impotence in the *Male*, and 2. Impotence in the *Female*.

I. IMPOTENCE IN THE MALE.

The causes of impotence may be—1. *Physical*, 2. *Mental*.

1. The *Physical Causes* are—*a*. Too tender or too advanced an age. *b*. Malformation or defect of the penis. *c*. Defect or disease of the testicles. *d*. Constitutional disease or debility.

a. *Age*.—The earliest age recognised by law for the marriage contract is 14 in the male, and 12 in the female. But the ecclesiastical courts look rather to the "habit, strength, and constitution of the parties," or whether they be *habiles ad matrimonium*; and the common law will hold infantile marriages, duly solemnized, valid, "when the parties on reaching the ages just stated do not demur to the contract."

The age of puberty, in both sexes, is subject to great variation. It is usual to recognise 14 years as its earliest advent in the male; but it may first show itself much later than this; and many cases are recorded of large development of the sexual organs in childhood. Casper alleges that the power of coition begins earlier and ceases later than that of procreation; and, that in Germany, the possession of the one dates from about the thirteenth, and of the other from the fifteenth to the sixteenth, year. (Vol. iii. p. 258.)

The signs of puberty are to be sought for in the general conformation of the body, the character of the voice, the growth of hair on the pubes, and the development of the organs of generation. If all the genital organs are found to have the usual manly development, it is safe to infer that complete sexual intercourse is possible.

But impotence may arise from old age as well as from immaturity; hence one of the questions raised in the celebrated Banbury Peerage Case—At what age do the powers of procreation cease?

In this case, tried in the House of Lords, and decided in 1813, the principal argument urged against the claimant was that the ancestor under whom he claimed was eighty years old at the date of the birth; but Sir Samuel Romilly, after stating that the law of England admits of no age at which a man may not become a father—there is no age, from seven upwards, at which a man is denied the privilege of having children—cited many medical authorities in its support. Dr. Gregory, of Edinburgh, says—"Magna autem de his rebus differentia; decantantur enim exempla senum in castris Veneris strenue merentium, postquam centum annos compleverant; neque sane dubium, aut adeo rarum octogenarium patrem fieri." Haller likewise pronounces a man of ninety to be capable of procreating. Parr became a father in his one

hundred and fortieth year. Lord Erskine, following on the same side, cited the case of Sir Stephen Fox, who married at the age of seventy-seven, and had a child born to him when he was seventy-eight, twins in the following year, and a fourth child when he was eighty-one. The Attorney-General, Sir Vicary Gibbs, who opposed the claimant's title, tacitly admitted the weakness of the objection on the score of age, by shifting his argument to the more secure ground, that age, though not a proof of impotency, is evidence of it. "The probability of the earl's begetting a child at eighty is very slight, and it is not increased by the appearance of another child two years later. Instances have been adduced of these extraordinary births, but none have been cited in which a man at eighty-two, having begotten a son, had concealed the birth of such son." It is clear, then, that no limit is fixed by law, or can be assigned by science, at which the power of procreation ceases. Old age, provided it be a robust old age, is obviously no impediment to procreation; and in the case of Lord Banbury, there is ample evidence of his having been able to take strong exercise till within a short period of his death.*

The finding of spermatozoa in the bodies of several men above 80 years of age, and of one æt. 96, lends confirmation to the facts founded on the fruitful marriages of old men.†

b. Malformation or defect of penis.—The experiments of Spallanzani and Rossi have shown that in animals complete sexual intercourse is not necessary to impregnation; but that the injection of semen by a syringe, while the animal is in heat, will suffice for that purpose; and John Hunter's ingenious expedient, recommended in a case of fistula in perineo, further proves that in the human subject the semen may be introduced in the same way during the existence of the venereal orgasm with the same result. But the cases to be cited under the head of Pregnancy prove more than this. They show that a female may become pregnant in consequence of intercourse taking place in a state of unconsciousness, even when attended by so little injury to the parts of generation as to attract no attention afterwards; also that pregnancy may occur in women with hymen intact. So that neither the introduction of the male organ nor the venereal orgasm is necessary to impregnation. It follows, then, that small size or partial mutilation of the penis is not to be accounted a cause of impotence. Provided that what exists or remains of the organ is large enough to admit of introduction within the

* See Sir Harris Nicolas's treatise on the Law of Adulterine Bastardy.
† See Casper, vol. iii. p. 258, and p. 291 et seq.

orifice of the vagina, and there be no impediment to the emission of semen, fruitful intercourse may take place. Thus, the removal of the glans penis; of the corpora cavernosa (as in a case quoted by Paris, from Piazzoni); of a very considerable portion of the organ (as in the case of a soldier quoted by Frank, in whom a large part of the penis was carried away by a musket-ball); did not occasion impotence. A still more extreme case is on record,* in which, after amputation of a diseased penis, there was only a very small protrusion of the organ on pressure, and yet the mutilated patient became the father of two children. Amputation of the penis close to its root would in all probability cause impotence, though, for the reasons already assigned, impregnation might not be impossible.

The opposite malformation, excessive development, whether normal or a consequence of disease, can also scarcely be regarded as a cause of impotence; for though it might render complete intercourse impossible, it need not prevent impregnation.

Nor would a malformation of the penis, in which the urethra opens on the organ itself, though not in the usual situation, entail impotence. Several such cases that did not result in impotence are on record, and among them instances in which the malformation was transmitted from parent to child; in one case, reported by Frank, through three generations.

When the opening of the urethra, instead of being upon the penis, is in the perineum, fruitful sexual intercourse cannot take place unless the semen be artificially introduced into the vagina, as in Mr. Hunter's case. But, as in all such cases, whether intentionally or by accident, the semen ejected from the remote opening might reach the vagina, and so cause impregnation, it would be unsafe to pronounce persons subject to such malformation to be incapable of fruitful sexual intercourse.

Hypospadians and *Epispadians* (pp. 19, 20), must be accounted incapable of complete sexual intercourse; and to become the parents of children must be assisted by artificial means;† or the discharged semen must in some unexpected manner be conveyed to the sexual organs of the female. The occurrence of cases of hereditary *hypospadia*, renders this event probable, while two cases at least of impregnation by hypospadians with the urethral orifice seated at the very root of the penis establish it beyond a doubt. Of these the case of the Hypospadian Johanna K., who became the father of a child similarly malformed, is the most

* Mr. Hurd in 'London Med. and Surg. Journal,' vol. iv.
† 'Ed. Med. and Surg. Journal,' vol. i. pp. 43, 132.

striking.* Of *Epispadia* Casper says that he knows of no example of impregnation by a man so afflicted; while of the two states he says "that of themselves" they "form no reason for assuming an incapacity for procreation, so long as it cannot be proved" in any given case that it is impossible for any semen to enter the vaginal canal.

Congenital phymosis, and a confinement of the penis to the scrotum by a peculiar formation of the integuments, are among the curable causes of impotence. Severe strictures, and such extensive disease of the prostate gland as would prevent the expulsion of the semen; and paralysis of the muscles of the penis, complete the list of the causes of impotence which have their seat in that organ.

c. Defect or Disease of the Testicles.—The excision of both testicles early in life occasions impotence; but when they are removed after puberty, the power of complete sexual intercourse may continue for a time, and a person so mutilated may even become a father, through the semen contained in the vesiculæ seminales. That sexual intercourse may take place for a considerable period after the removal of both testicles is proved by a case related by Sir Astley Cooper.† For about twelve months after the loss of the second testicle there were emissions in coitu; then sexual intercourse took place at distant intervals, but without émission; and, becoming less and less frequent, ceased at the end of ten years. Casper, on the authority of Peter Frank, tells us of four castrated soprano singers, who were banished from a small Italian town for their many sexual misdemeanours. The possibility of fruitful sexual intercourse taking place after castration, rests on the discovery of apparently good semen in the vesiculæ seminales at a considerable interval after the removal of the testicles as in a case cited by Otto; on the analogy of animals; and on at least one instance in the human subject. Sedillot cites a case on the authority of Boyer, in which after the removal of both testicles, a man became a father.‡

There has been much unnecessary discussion as to the possibility of a man with only one testicle having children; but as impregnation cannot be supposed to depend on the quantity of the semen, we may safely affirm that one sound testicle is to the full as efficient as two. Men whose testicles are situate in the abdomen or in the inguinal canal are not only capable of sexual intercourse, but (as in the case of a criminal cited by Mahon) may earn a

* Case by Traxel cited in Casper's Handbook, vol. iii. p. 250.
† 'Med. Chir. Rev.,' vol. xviii. p. 390.
‡ Sedillot's 'Manual,' p. 17.

character for extreme licentiousness. The question of their power to impregnate will be considered presently. (*See* Sterility).

Small size of testicle is not sufficient ground for inferring impotence; for though there are cases on record in which it has coincided with a total absence of sexual desire, there is at least one well-authenticated instance in which both penis and testicles being originally very small, there were sexual desires, erections with emissions, gradual increase in size, and fruitful intercourse.* The sufficiency of even a single small testicle is supposed to have been shown in a case which occurred in the reign of Elizabeth. Willimet, the first wife of one John Bury, alleged that he was impotent; and on inspection by two physicians he was found to have but one testicle the size of a small bean, while she was a virgin. On this and other circumstantial evidence, the ecclesiastical court annulled the marriage. But Bury took a second wife, by whom he had a son, and on his legitimacy being called in question, the common lawyers were unanimously of opinion that the ecclesiastical court had been misled, and pronounced the first marriage valid notwithstanding.†

Of the *diseases* which affect the testicles, and cause impotence, the wasting that sometimes follows attacks of cynanche parotidea is the most important. Foderé witnessed several such cases in deserters condemned to labour on the canal at Arles, and Larrey in many soldiers of the army of Egypt. The testes lose their sensibility, become soft, and shrink to the size of a white French bean, and when both are affected, the beard grows thin, the intellect fails, and impotence results. Larrey could not trace the disease to previous attacks of gonorrhœa, but attributed it to the use of the brandy of dates.

Elephantiasis and malignant diseases, such as scirrhus and medullary sarcoma, may also lead to the same result; but it would not be safe to pronounce in favour of impotence except where the entire structure of both testicles is affected.

Congenital scrotal hernia, long standing inguinal hernia, and tumours of large size involving the genital organs, or affecting the lower part of the abdomen or upper part of the thighs, may constitute mechanical impediments to sexual intercourse.

d. Constitutional disease or debility.—Diseases which occasion extreme debility may become causes of impotence (temporary or permanent), through the weakness to which they give rise. There must always, however, be great difficulty in determining the

* Wilson: 'Lectures on the Urinary and Genital Organs,' p. 424.
† Hargrave's 'State Trials,' vol. x. p. 24.

degree of debility or exhaustion from disease or from age and natural decay which entails impotence.

But the diseases most likely to occasion impotence are those that affect the nervous centres, especially diseases of the spine, whether arising from internal cause, or from mechanical injury. Hemiplegia, from brain disease, and paraplegia, from disease or injury of the spinal cord, might be supposed to give rise to impotence; but that fruitful sexual intercourse may take place within a few weeks of a well-marked attack of hemiplegia is proved by the cases adduced on the occasion of the trial of Legge *v.* Edmonds. After partial recovery from paraplegia, also, the power of fruitful sexual intercourse does not appear to be lost.*

Case of Legge v. *Edmonds.*—The following is a careful summary of the facts of this case which are interesting in a medico-legal point of view. Mr. Legge, of Newent, married August 25, 1835, and died June 24, 1844. His wife was delivered of a daughter March 23, 1837, and again of a daughter October 30, 1844, being four months after the death of Mr. Legge. The first child attained the age of two years; the second survived four years. The legitimacy of the second child was called in question, partly on account of the state of health of Mr. Legge at the date of the conception, and partly in consequence of the alleged adultery of Mrs. Legge with the defendant, to whom she was subsequently married, and by whom she had children. Mr. Legge was an athletic man, and a free liver, occasionally drinking to excess, but not an habitual drunkard. On November 4th, 1843, when about thirty-five or thirty-six years of age, he had a well-marked apoplectic seizure, with loss of speech and hemiplegia of the right side, for which he was actively treated, and was so far recovered by November 27th, little more than three weeks from the date of the attack, as to cease taking medicine. The hired nurse left him at the end of five weeks. After the lapse of a week his speech was partially restored; he left his bed at the end of a fortnight; came down stairs as early as the end of the third week; by the end of the fourth week he was walking in the town, and drank tea out. At or about this period he was seen walking about by more than one witness. On December 7th (little more than a month after the attack), he went to Ledbury in a gig, driving himself part of the way, and signed his name at the bank, taking his hand out of a sling for the purpose. On December 27th he transacted business as usual, and wrote his name. He dined out near Newent before Christmas-day, and

* See a case quoted from M. Brachet by Curling on 'Diseases of the Testes,' 2nd edit. p. 371.

rode on horseback before the end of the year. On January 6th he visited Gloucester, and had transactions with several tradesmen. Before the end of the month he supped there, and opened oysters, and on the 31st attended a meeting, at which he took off his coat and challenged one of the company to fight. The most conclusive evidence was brought forward to prove that between the end of November, 1843, and the end of January, 1844, he had repeatedly transacted business and written his name, walked about without support, driven a gig, ridden on horseback, and leaped hurdles, gone out shooting, and killed game. It is also proved by the testimony of several witnesses that he had so far recovered before the end of January as to seem in perfect health. He had no new attack of illness till February 28th. His death in the June following was attributed to a general break up of the system, following dropsy, and disease of the liver.

From the foregoing summary, carefully compiled from the notes of Mr. Charles Jones, solicitor for the defence, it appears that there were no medical grounds for assuming incapacity for fruitful sexual intercourse at the end of January, the presumed date of the conception of the daughter whose legitimacy was contested. The adverse opinion of Drs. Taylor and Carpenter was based on other than medical considerations. The inquiry, commenced at Cheltenham, was continued in London, when the opinion previously expressed by Dr. Semple, Mr. Walsh, and the author was confirmed by Drs. F. Bird and Blundell, and the following facts were given in evidence:—1. E. K., æt. 58, when thirty-three years of age, had a well-marked attack of hemiplegia of the right side, which has left him lame, and with his speech slightly affected. He alleges that he had connection with his wife within a week of his seizure, that his sexual powers have not been impaired, and that since the attack he has had three children always considered as his own. His wife gives three weeks as the extreme limit of time after the attack at which connection took place. The facts of this case were confirmed by Mr. Wetherfield, of Covent Garden, who added that he had known other cases of hemiplegic patients begetting children. 2. W. D., æt. 32, had an attack of hemiplegia of the right side at the early age of twenty-six, and a second when twenty-eight years old. Intercourse took place within a fortnight of the first attack; and there have been three children of which the first was born about eighteen months from the first seizure. Neither husband nor wife had any doubt that the children were their own.

In both these instances the recovery was less complete than that of Mr. Legge.*

* The reader will find a full account of this case, differing in some material

Certain drugs, taken in single large doses, or used habitually in excess for long periods, such as opium, spirituous liquors, and tobacco, may give rise to impotence. Other substances of less power, such as camphor, coffee, and nitre, have been mentioned as causes of impotence, but probably with insufficient reason.

Masturbation and early and excessive sexual indulgence are also acknowledged causes of impotence.

2. *Mental causes.*—Excessive passion, timidity, apprehension, superstition, fear, aversion, and disgust, have been known to occasion impotence. With the exception of the last-named emotions—aversion and disgust—the rest are transitory, and curable. That impotence with one female is not inconsistent with sexual ability in respect of others is proved by the case of John Bury, already referred to, as well as by that of the Earl of Essex, who admitted his inability to know the Countess, but denied his impotence as to other females.*

II. IMPOTENCE IN THE FEMALE.

The causes which prevent sexual intercourse in the female are, 1. *Narrowness of the vagina*, existing in all subjects before puberty, and in rare instances in the full-grown adult. In the latter, the defect may be remedied by emollients and cautious dilatation. 2. *Adhesion of the labia* from inflammation, and obliteration of the vagina from the same cause. 3. *Absence of the vagina*, accompanied in some cases by absence of the uterus. 4. *Imperforate hymen.* This often belongs to the class of curable causes. 5. *Tumours in the vagina*, such as polypi, scirrhous formations, prolapsus uteri, and prolapsus vesicæ. There are other causes which render sexual intercourse so difficult or painful as to deserve mention in connection with this subject. Of these the most important are—Unusual shortness of the vagina; inflammatory or malignant diseases of the vagina or uterus; extreme sensibility; a fistulous communication between the vagina and rectum, and internal piles. Of these some are obviously curable, others admit of no relief.

Sterility.—This may occur both in women and in men. In *women* some of the physical causes, such as absence of the uterus, closure of the neck, or of the Fallopian tubes, may escape detection during life. There are also curable causes of sterility, such as profuse discharges, menorrhagia and leucorrhœa, and altera-

points from the preceding, and not comprising the cases of E. K. and W. D., in Taylor's 'Medical Jurisprudence,' sixth edition, p. 675.

* See Hargrave's 'State Trials,' vol. i. p. 315; or abstract by Beck, p. 54.

tions in the secretions of the vagina and uterus;* as well as causes little understood, but proved to exist by the fact that women sterile with one husband have become fruitful with another. Promiscuous intercourse, another acknowledged cause, is not a permanent one, as is shown by the fruitfulness of married convicts who had been previously prostitutes.

Sterility in men is more interesting in a physiological than in a medico-legal point of view. It is certainly present in many men who are capable of complete sexual intercourse, and in others in whom there is complete mechanical intercourse without emission. Mr. Curling recognises three causes of male sterility:—malposition of the testicles, obstructions in their excretory ducts, and impediments to the escape of the seminal fluid. The second of these causes may be brought about by double "epididymitis" following gonorrhœa, and by scrofulous and malignant degeneration affecting both sides; also by congenital absence of the 'vasa deferentia.' The third cause may be induced by stricture of the urethra, causing the semen to regurgitate into the bladder; also by other diseases giving rise to like impediments. The first cause is the most interesting, for it appears to entail sterility without causing impotence. Mr. Curling gives a table containing nine cases (four of his own observing), in 2 of which both testicles were in the abdomen, in 2 one or other was there, in 2 both in the groin, the others being mixed cases; and in all these cases there was sterility, and the semen, on examination, was found destitute of spermatozoa. On the other hand, in three cases of non-descent of both testicles, by Mr. Poland, Mr. Cock, and Mr. Durham, the men were married and the reputed fathers of children. Two of them had married twice, and one had children by both wives. Mr. Curling, relying on the ascertained sterility of many of these "cryptorchids," coupled with the absence of spermatozoa, and attaching due importance to analogous observations on animals, is disposed to call in question the claims to paternity in these cases. But as, in order to do so, it would be necessary to suppose the most improbable coincidence of four wives unfaithful with three cryptorchids, the safest course is to adopt the author's own admission contained in the words, "I see no valid reason why there should not be exceptions." The rule must be held to be established.† Casper says of this class of persons, "Experience proves

* M. Donné has shown that these secretions, in females apparently in good health, are sometimes such as instantly to destroy the spermatozoa.

† Observations on Sterility in Man, with cases. By T. B. Curling, F.R.S., Surgeon to the London Hospital, &c. 'British and Foreign Medico-Chirurgical Review,' April, 1864.

that cryptorchids are perfectly capable of procreation, and there are, *à priori*, no physiological reasons for doubting this." (Vol. iii. p. 256.)

Directions for conducting examinations in cases of alleged impotence:—

1. Note the age, general appearance, habit of body, and state of health, of the person complained of, and ascertain what diseases he or she may have previously laboured under.

2. Examine the sexual parts with great care; ascertain their degree of development, and explore such openings or canals as may be discovered, by the sound or catheter. Ascertain the condition of the urethra of the male, and the state of the prostate.

3. No gross or indelicate manipulations need be practised, nor artificial stimulus employed.

4. These examinations can only be safely intrusted to skilful and experienced medical men. The examination of females should be conducted by accoucheurs, the jury of matrons being obviously incompetent.

RAPE.

Rape, which was formerly a capital offence, now entails penal servitude for life as its maximum punishment, as does also the carnal knowledge of any girl under 10 years of age. The carnal knowledge of any girl between the ages of 10 and 12 is punishable by penal servitude for three years. Indecent assaults on females and attempts on girls under 12, are punished by imprisonment for any term not exceeding two years. (24 and 25 Vict., cap. c., § 40 et seq.)

Rape being defined as "the *carnal knowledge* of a woman forcibly and against her will," a question has arisen as to the meaning of the term *carnal knowledge*, and whether it implies penetration and emission, or penetration only. Though this difficulty might be supposed to have been set at rest by the 9th of Geo. IV., chap. 31, which distinctly provides that neither in cases of rape, nor in offences *contra naturam*, shall it be necessary to prove the actual emission of seed, but that the carnal knowledge shall be deemed complete upon proof of penetration only, much difference of opinion continued to exist among legal writers, and conflicting decisions were given from the bench, till at length it came to be understood and universally admitted that proof of emission is not required. A question was next raised as to the meaning of the word "penetration," and it was at length decided, after further conflict of legal opinions and de-

cisions, that any introduction of the male organ within the vulva constitutes penetration.*

The least possible introduction, then, of the male organ within the vulva, even short of the rupture of the hymen, and without emission, constitutes a rape, if done forcibly and against the will of the female, and the facts to be established are:—1. Forcible penetration, in this limited sense of the term; and, 2. In the case of females above twelve years of age, that the force was used against the will of the complainant. The subject, therefore, divides itself into two parts—the question of penetration, or, in other words, the *physical signs* of rape, and the question of consent. In deciding the first question the court is guided by medical evidence; the second it decides on the evidence of other witnesses.

As the law makes no distinction between married and single, chaste and unchaste, and does not limit the time after the alleged commission of the offence at which an accusation may be preferred, the examination of the female may have to be made under very different circumstances in different cases.

PHYSICAL SIGNS OF RAPE.

Though, as the explanation already given of the meaning of the term penetration shows, it is not necessary to prove the existence of any definite amount of injury (as for instance, the rupture of the hymen in those who have not had previous sexual intercourse), the medical man should make a minute and careful examination of the parts of generation, so as to be able to give a clear description of the injury they have sustained. And though the fact of emission need not be proved, the discovery of semen on the person of the female, or on her dress, must obviously be of very great importance.

The duty of the medical man when called on to examine the person of a female said to have been violated will therefore consist in an examination: 1. Of the parts of generation, with a view to an exact description of the injury they have sustained; 2. Of the body and limbs of the female, with a view to discover bruises, scratches, or other evidences of resistance to the alleged violence; 3. Of the linen worn by the female at the time of the alleged rape, with a view to the discovery of spots of semen or of blood, and, in some cases, of other discharges. It may also be necessary to examine the person and linen of the accused.

* See Archbold's 'Pleading and Evidence in Criminal Cases.'

1. *Examination of the parts of generation.*—Before considering the injuries these parts may sustain, it will be necessary to inquire into the value of the hymen, and of other alleged signs of virginity; for the crime of rape is most frequently committed on the person of a female who has not previously had sexual intercourse; and it is usual, in the case of adult females, to endeavour to rebut the charge of rape by alleging previous unchastity—a question on which the medical examiner may have to express an opinion.

The Hymen.—Strange as it may seem, the very existence of this membrane has been disputed; and Male, Beck, and Devergie, give long lists of those who affirm and of those who deny its existence; but the former have the advantage, both in numbers and authority.

Orfila did not find it wanting in one of more than 200 subjects, which he examined. Gavard found it in the fœtus, in the new-born infant, in young women from 23 to 25 years of age, and in one of 50. Bennach, of Marseilles, saw it in a woman of 60. Devergie found it invariably present in new-born infants, and met with it in women of different ages exposed at the Morgue, of whom one was 65 and another 72. The same author twice observed the labia minora united through their whole extent, leaving a small aperture above corresponding to the meatus urinarius; and once he found the vagina closed by a false membrane within the labia minora, having a perfect hymen behind it. Devergie concludes, from a careful review of all his authorities, that the hymen is an almost constant formation, recognizable by marked characters in 99 cases out of 100; and he traces the differences of opinion that have existed to variations in its form and size.*

The hymen is usually found as a semilunar fold, concave before and convex behind, bounding the entrance of the vagina below, and losing itself behind the labia minora in the circumference of the orifice. Another form is that of a circular membrane, perforated in the centre, and adherent by its entire circumference. A third form consists of the same circular membrane, but with a small opening above, corresponding to the meatus urinarius. A fourth, but most unusual, form is that of filaments of mucous membrane uniting the caruncuIæ myrtiformes.

The hymen, comparatively small at birth, enlarges by degrees, and especially about the period of puberty; when its free edge becomes relaxed and thrown into folds. These, when ruptured,

* Consult Devergie, 'Des Attentats à la Pudeur.'

give rise to those small pyramidal tubercles, from three to six in number, known as the *carunculæ myrtiformes*, which may, therefore, be taken as marks of the previous existence of the hymen.

The recent destruction of the hymen proves the recent use of force; and if there are other marks of violence on the parts and on the person of the female, there can be no reasonable doubt of the commission of a rape, as far as that crime admits of being proved by physical signs.

When the destruction of the hymen is recent, the *carunculæ myrtiformes* are found swollen and inflamed; but they gradually wither and shrink with time.

This absence of the hymen, and substitution of the carunculæ, must not be taken as proof that the female had had previous sexual intercourse, for the membrane may be otherwise destroyed: from within, if the aperture be small, by the first menstrual flux, or by the accumulation of other discharges; from without, by accident, or by foreign bodies purposely introduced; also by disease. It may even be originally wanting, as in a case related by Capuron.

On the other hand, the presence of the hymen must not be accounted a certain sign of chastity; for it has remained intact after sexual intercourse, and even after the birth of children. Ambrose Paré, Ruisch, Osiander, Nägele, Capuron, Baudelocque, and others give cases of mothers in whom it was ruptured by the child, or divided by the knife; and Tolberg, on the authority of the elder Meckel, cites the case of a woman in whom the hymen was preserved circular and tense after the birth of a fœtus of five months, enveloped in all its membranes. Still a perfect hymen, with the parts of generation and the breasts conforming to the virgin type, affords the strongest presumption of chastity.

Besides the intact condition of the hymen, or its recent rupture, other signs of virginity have been enumerated, such as the fresh colour, firmness, and elasticity of the labia, the integrity of the fourchette, the narrow and rugose state of the vagina, a plump and elastic condition of the breasts, the difficulty and pain attending intercourse, and the flow of blood. But all these signs are fallacious. This condition of the labia is not always destroyed by repeated intercourse, and in the state of the breasts many widows and mothers may compare with undoubted virgins. The fourchette may remain unruptured after repeated intercourse, and even after child-bearing; and the narrow and constricted vagina is not only not peculiar to virgins, but may be imitated by the use of astringents, while the opposite state naturally present during the menstrual period may be induced by profuse menstrual

or leucorrhœal discharges. The pain attending a first connection and hæmorrhage are still more fallacious, as both may occur from relative disproportion.

That the fact of previous sexual intercourse is not easy to ascertain, and that the usual signs of virginity may remain after long habits of unchastity, is well illustrated by the following case.*

Two young women of genteel appearance were attacked in the public streets by some young men, who called them opprobrious names, and told the passers-by that they were no better than common prostitutes. Some good-natured persons resented this conduct, and took the girls' part; and a complaint was lodged on their behalf against their defamers, who were summoned before a magistrate. The defendants pleaded a justification, while the females, on the contrary, stoutly insisted on their purity, and even offered to submit to inspection by a medical examiner,—which the opposite party dared them to do. A sworn inspector, clever and conscientious, was appointed by the magistrate, and reported that it was totally out of his power to say anything certain as to one of the females; she might or might not be a virgin; but that the other had *probably* had some intercourse with men, though he could not assert the fact positively. Yet it subsequently came out that these young women had actually been for some time on the registers of the police, and had both had repeated attacks of the venereal disease.

The physical signs of rape consist in marks of violence on the organs of generation, proportioned to the force employed, the resistance offered, and the relative disproportion of the parts. In the adult virgin (after complete penetration) the hymen would be ruptured, the fourchette might be torn; and the parts would be covered with blood. In young children, there may be no penetration, and therefore no destruction of the hymen, and no hæmorrhage, but bruising of the external organs. After some hours, there will be marks of recent inflammation, with increased heat and swelling, with profuse discharge, at first of mucus tinged with blood, then of a muco-purulent fluid, of a greenish-yellow colour, and glutinous character.

These are the appearances present when the injuries are recent; but at the end of three or four days the inflammation will have subsided, the parts may heal, and no trace of the injury may remain. The soreness resulting from the injuries causes a difficulty in walking, and a peculiar gait, which lasts for a day or two in the adult, but longer in children who have been much in-

* Parent-Duchatelet, 'La Prostitution dans la Ville de Paris.'

jured. There is also complaint of pain in micturition, and sometimes in relieving the bowels.

The marks of violence are *cæteris paribus*, less distinct, and the resulting inflammation less intense, in women who have had sexual intercourse, have borne children, are at the menstrual period, or are suffering from any profuse discharge.

These marks of injury to the parts of generation may exist, and yet no rape have been committed; for a first intercourse, with full consent, or a great disproportion of parts in one accustomed to sexual intercourse, would give rise to the same appearances.

Injuries to the organs of generation have also been fraudulently produced, in order to support a charge of rape. Foderé cites a case in which inflamed spots were produced by the pressure of a coin.

Appearances resembling those due to violence, may also be occasioned by disease, as was first shown by Dr. Percival. Jane Hampson, æt. 4, was admitted an out-patient of the Manchester Infirmary, February 11, 1791. The mother stated that the child first complained of pain in making water the day before. This led her to examine the parts, which she was surprised to find highly inflamed, sore, and painful. The child had slept two or three nights in the same bed with a boy fourteen years old, and had complained of being very much hurt by him. Leeches and other external applications, with appropriate internal remedies were prescribed; but the child grew weaker, and died on the 20th of February. A coroner's inquest was held; prior to which the body was inspected, and the abdominal and thoracic viscera being found free from disease, Mr. Ward, the surgeon attending the case, gave it as his opinion that the child's death was caused by external violence. A verdict of murder was accordingly returned against the lad. Not many weeks however, elapsed, before several similar cases occurred, in which there was no suspicion of external violence, and some in which it was certain that it had not been offered. A few of these patients died. Mr. Ward was convinced that he had been mistaken, and informed the coroner of his reasons for changing his opinion. Accordingly, when the boy was called to the bar at Lancaster, the judge told the jury that the evidence adduced was not sufficient to convict; that it would give rise to much indelicate discussion if they proceeded to the trial, and that he hoped they would acquit him without calling witnesses. With this request the jury complied. The disorder in these cases, says Dr. Percival, had been a typhus fever, accompanied with a mortification of the pudenda.*

* 'Medical Ethics,' pp. 103 and 231.

A similar complaint has been described by Mr. Kinder Wood. It was preceded by febrile symptoms for about three days. Attention was then called to the seat of the disease, by complaints of pain in voiding the urine, and when the genital organs were examined, one or both labia were found enlarged and the seat of a dusky inflammation, which soon extended over the clitoris, nymphæ, and hymen. Ulceration succeeded, leading to progressive destruction of the external organs. The disease seemed to be a peculiar kind of eruptive fever, and proved very fatal.*

Lawrence, in his 'Surgical Lectures,' also described a peculiar inflammation of the external organs of children, as not only a serious affection in itself, but apt to be confounded with syphilis, so as to give rise to the suspicion that the children had been ill-used. In some instances serious judicial trials had been the result. The disease occurs in young subjects of from four or five or eight or ten years of age; and consists of inflammation of the labia and external organs, which assume a deep, dusky red colour, and become the seat of foul ulcers, with a tawny gray, and sometimes an actual sloughing surface, attended with a thin fœtid discharge, with feverishness, restlessness, great pain, and very considerable disturbance of the health of the child. The disease differs widely from syphilis, and the ulcers have characters totally different from those of any primary venereal sore. Lawrence had to give evidence in the case of a child suffering from this affection, who, in consequence of professional opinions that it was the venereal disease, was interrogated into the idea suggested and strongly entertained by the parents, that a certain youth had done something or other to her. He was taken to Bow-street, examined, and tried at the Old Bailey.

Wilde, of Dublin, describes a like affection of the parts of generation of young children in connection with leucorrhœal ophthalmia, and states facts to prove that both affections are contagious.†

We have seen several cases of this deep-coloured inflammation of the genitals with profuse discharge, not proceeding to ulceration; and have generally found the friends suspicious of violence (G.).

In reference to all these forms of disease, it should be borne in mind, that they attack only young children, and that the same disorder sometimes prevails at the same time, in the same place.

* 'Med. Chir. Trans.' vol. viii. p. 84. See also Beck's 'Medical Jurisprudence,' art. Rape, for further references to authors.

† 'Medical Times and Gazette,' Jan. 17, 1857. See also Mr. Kesteven in same Journal, April, 1859.

2. The evidence afforded by injury to the parts of generation may derive confirmation from an examination of the person of the female. If there has been great violence and much resistance, bruises and scratches will be found on the groins, thighs, and knees, and on the arms and chest; and the clothes may also be torn in the struggle.

Marks of violence, then, on the parts of generation, corroborated by bruises and scratches on other parts of the person, form the principal physical signs of rape.

3. *Examination of the Linen.*—The linen worn by the female at the time of the alleged rape may furnish valuable negative evidence, or may issue in the discovery of spots or stains of blood, of menstrual fluid, of semen, or of other discharges.

Spots of Blood.—When the injury is recent, the linen will be spotted with pure blood of a uniform red colour; but when the first hæmorrhage has ceased, the blood will be mixed with mucus, producing stains less defined, reddish, or yellowish red, lighter in the centre, darker at the circumference.

These spots of blood, or of discharges tinged with blood, coinciding with marks of violence, afford a strong presumption of rape.

For the chemical tests and microscopic characters of spots of blood, the reader is referred to the chapter on Wounds.

The menstrual fluid.—It is necessary to be on our guard against confounding blood-stains with those produced by the menstrual discharge. This fluid is secreted by the lining membrane of the uterus; is of a rich cherry-red colour, not brightened by contact with air, and passes by exposure to a brownish-red. It contains less fibrin than blood, and does not form so firm or thick a clot; but it is sometimes discharged with clots of blood. It has a characteristic sour odour, and an acid reaction, due to the presence of free phosphoric and lactic acids. It also contains mucous globules and epithelial scales from the uterus and vagina. By these properties the unmixed menstrual fluid may be distinguished from blood; but the spots or stains which it forms are not readily distinguished from stains of blood when blended with mucus. And this is especially true of the soiled linen of the class on whom the crime of rape is most frequently committed. As to stains on linen, therefore, it is safe to adopt the statement of Casper, "that there is no distinguishable difference between the two kinds of blood." The nature of the fluid might be ascertained by plugging the vagina. If it were found to flow from the upper part of the passage, it might be safely inferred that it was menstrual.

If the menses were flowing at the time of an alleged rape, blood would be mixed with the discharge, and would be found adhering to the injured parts, or in copious clots near the scene of the violence.

This coincidence took place in the case of Mary Ashford:—

The menses were flowing at the time of the alleged rape, and *coagulated* blood was found at the spot where the connection took place, in the middle of the impression of a figure on the grass. The parts of generation were torn, and covered with coagulated blood; and the shirt and pantaloons of the accused, Abraham Thornton, were also bloody. He confessed the connection, but pleaded consent. The dead body of Mary Ashford was found next morning in a pool of water.*

Semen, and seminal spots.—When a female is examined soon after a rape, semen may be discovered at the orifice of the vagina, or on the other parts of generation; or seminal spots may be found on the shift. The real character of the fluid may be determined by the microscope, which reveals the presence of certain characteristic bodies, variously designated as *spermatozoa*, *zoosperms*, *seminal animalcules*, and *cercaria seminis*. They exist in the semen of male animals that have reached the age of puberty, diffused through the semen in large but variable numbers, mixed with granules or corpuscles of much larger size. They consist of a long slender filament surmounted by an oval or pear-shaped head. They are very minute, their entire length often not exceeding the 600th of an inch, and the pear-shaped head being about half the size of the human red blood-corpuscle. For several hours after the death of the animal to which they belong, the filament has a peculiar lashing, undulating, or vibrating movement. But when they have ceased to move, they may still be detected by their peculiar shape, which they retain even when dry; and they have been detected, after long intervals of time, in the liquid obtained by steeping seminal stains in a small quantity of distilled water. Devergie found them in stains ten months old, Casper at the end of a year, Bayard after three, and Ritter after four years.† They also resist putrefaction, and have been observed in putrid semen kept for ten weeks.‡

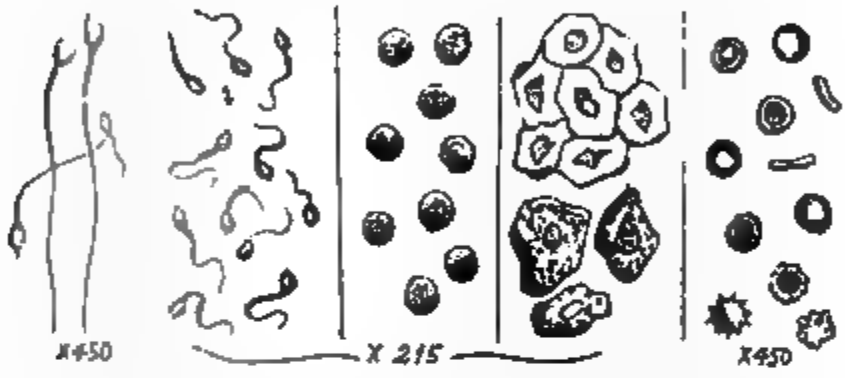
* See this case at length in Cummin's Lectures, 'Med. Gaz.,' xxi. p. 386. The case occurred in 1817, and excited much interest at the time.

† A case of rape, by Dr. Henry Munroe, accompanied by an engraving, showing the spermatozoa, the blood globules, the epithelial scales of the menstrual discharge, and the mucous bodies as seen in the liquid obtained by steeping the stains in distilled water, will be found in Beale's 'Archives of Medicine,' vol. i. p. 139.

‡ Dr. John Dewy, 'Edin. Med. and Surg. Journ.' vol. iv. p. 15.

In the annexed wood-cut (fig. 5) the spermatozoa (1) and the blood disks (2) are seen magnified 450 diameters; while the spermatozoa (3), the mucous bodies (4), and the epithelium scales (5), are shown under a lower power, of 215 diameters.*

Fig. 5.



The appearances and motions of the spermatozoa are quite distinctive; but it is right to state that M. Donné has described and depicted, under the name of Trichomonas vaginæ, an animalcule occasionally encountered in vaginal mucus, and especially in the discharges of females careless of personal cleanliness. It is found mixed with granular bodies of larger size than those of semen, and the head is three times as large as that of the spermatozoa. It has several granules in its interior; and a row of from four to six short cilia spring from its circumference.

Fig. 6.

But seminal spots have other characteristic properties. They are stiff as if starched; of a grayish tint, best seen by placing the linen between the eye and the light; and when moistened give out the well-known seminal odour. If held near the fire—(taking care not to scorch the linen)—the spots change to a yellow fawn colour, and several small whitish spots, not previously perceived, make their appearance. Orfila pronounced this effect of heat to be characteristic, alleging that it does not take place with any other healthy or morbid discharge; not with vaginal mucus or the lochia; nor with gonorrhœal discharge or fluor albus. Pure nitric acid gives to the solution of semen in water a slight tinge of yellow, but causes no precipitate.

The change of colour in the spot when held near the fire, and the peculiar odour of the solution, are highly characteristic. The

* 1 and 3 are from Griffith and Henfrey's 'Micrographic Dictionary;' 3, 4, and 5 after figures in Beale's 'Archives,' vol. i.

absence of precipitate with nitric acid is less conclusive.* Casper commends a method of Lassaigne's, by which, on *linen* or *cotton* textures, the seminal spot, with others not caused by albuminous compounds, may be distinguished from secretions which contain albumen, and therefore sulphur. The spot is moistened with a solution of oxide of lead in liquor potassæ, and dried at 68° F. The seminal stain undergoes no change, while the other stains, after a few minutes, assume a dirty yellow or a sulphur yellow hue. (Vol. i. p. 205.)

But though the discovery of zoosperms in a seminal spot is conclusive as to its nature, it must be understood that a stain may have been caused by an emission and yet contain no zoosperms; for it appears from numerous observations on the bodies of men who have died by various forms of violence, that out of 22 young and middle-aged adults (several of them powerful and vigorous men) the organs contained numerous zoosperms in 5, few in 9, and none in 8; while of men above 50, 3 had them in large numbers, and 3 in small, while in three others they were not discoverable. Duplay also found the zoosperms absent in 14 out of 51 old men. A vigorous naturalist, 60 years of age, accustomed to the use of the microscope, examined, with Casper, his own semen after coitus, and they found every variation from no zoosperms at all to zoosperms described as innumerable, and from few or many *small* to few *large*. The facts thus industriously collected certainly justify Casper's conclusion "that though stains are proved to be of seminal origin when these specific zoosperms are found in them, yet that the absence of spermatozoa does not prove that these stains have not been caused by human semen." (Vol. iii. p. 296).

Of the characters of seminal spots, other than the discovery of zoosperms, it should be stated that, though available when we are dealing with clean linen, they are of little value when we have to do with the soiled garments of the poor. In preparing the spot for examination, care should be taken not to destroy the zoosperms by rough usage. It should be cut out, placed in a watch-glass with a few drops of distilled water, and gently moved about with a glass spatula. After a quarter of an hour the stained tissue will have become softened and permeated with water. It should then be carefully removed, and allowed to drain. From the soaked stain a slightly opalescent fluid may be squeezed with a glass rod on a clean microscopic slide, covered with a disc, and submitted to microscopic examination with a power of not less

* Orfila: 'Traité de Médecine Légale,' vol. i. pp. 156 et seq.

at a period, the disease should be detected, it wou
male unchaste if it were absent in the accused, bu
a strong corroboration of the charge if present. In
of rape based on the existence of a purulent o
ent discharge in young females, the ascertained ab
rhœa in the accused would be of the utmost impor
efence. As the gonorrhœal discharge cannot be disti
certainty from the purulent or muco-purulent disc
ren, or from the highly coloured leucorrhœal discharg
great caution is needed in forming an opinion base
e of any existing discharge.
e inferences drawn from the state of the parts of ge
n, and linen of the female may be strengthened by
amination of the accused.—If examined soon a
his person may bear distinct marks of resistance;
worn at the time may be found soiled with blood an
nay also have used such force as to cause a ruptu
m. On the other hand, the accused may prove t
, or of too tender, or too advanced, an age to b
eable with rape; or it may happen that he is imp
case the charge must fall to the ground.
legations of rape are sometimes confirmed by an insp
pot on which the offence was alleged to have b
d. It may bear distinct traces of a struggle, and
ed with blood.
hen death follows rape, the parts of generation,
itself, will have to be carefully examined, and the
extent of all injuries ascertained. The mouth s

The sufficiency of the resistance, and the question of consent generally, are reserved for the jury, guided by the following considerations:—The previous character of the female, and her relations with the accused; the motives that may have actuated her in bringing the accusation; the place and circumstances in which the crime was alleged to have been committed; the time that elapsed before complaint was made; whether, if other persons were near at hand, her cries were heard; and whether, if discovered, she made resistance and cried out before the discovery. The question of consent has of course no place in the case of children under ten years of age, of idiots, or of females in a state of unconsciousness, however produced.

This question of consent has been summarily answered, by alleging the impossibility of committing the crime on a woman of ordinary strength in full possession of her senses. That this, though very difficult, is possible, is sufficiently proved by Case LIV., p. 311, vol. iii., of Casper's Handbook; but as the term rape is now understood, the offence must be admitted to be possible if the assailant is a strong man, or if there is great disparity of strength. The female, too, may faint from fright, or yield to threats of worse violence.

Two other questions still remain to be discussed. 1. Can a female be violated during sleep without her knowledge? and, 2. Does pregnancy ever follow rape?

1. *Can a female be violated during sleep without her knowledge?*—That a rape may be committed during the *stupor* produced by narcotics, there is no doubt; that a female, accustomed to sexual intercourse, may be violated during profound sleep, is also highly probable;* but that this should happen to a virgin is in the highest degree improbable. Violation is here used in the sense of forcible and complete sexual intercourse; but under the head of pregnancy, cases will be cited to prove the possibility of intercourse with a sleeping woman being followed by pregnancy, which has taken the female by surprise—a proof that the connection was not accomplished with violence.

2. *Does pregnancy ever follow rape?*—Pregnancy may follow unconscious connection; hence the venereal orgasm is not a *sine quâ non*: it may also follow a first intercourse with consent. It is, therefore, in the highest degree improbable that an event

* In the year 1840, I was consulted by a poor woman, who, after mentioning other complaints of little importance, stated that she was somewhat alarmed by the fact of her sleep being so heavy that she was with difficulty roused. She added, by way of illustration, that her husband had assured her that he had frequently had connection with her during sleep.

which may follow an act unconsciously performed, and in spite of the pain of a first intercourse, should be prevented even by the most passionate repugnance.

It now only remains to give some short directions for medico-legal examinations in cases of alleged rape.

1. Visit the female without giving time for preparation, and note the time of the visit and that at which the offence is stated to have been committed. Avoid leading questions, especially in the case of children.

2. Ascertain the age, strength, and state of health of the complainant; examine the injuries of which she complains, and see whether they correspond with the cause to which she attributes them.

3. Examine the organs of generation, and note whether they are bloody, swollen, abraded, inflamed, or ulcerated; whether there is any discharge, and whence it flows; whether the hymen and fourchette are injured, and if so whether recently, and whether the caruncule myrtiformes are present; ascertain the date and origin of marks of violence, and determine whether they might not have been produced by other than the alleged cause, as, for instance, by foreign bodies, purposely applied to, or introduced into, the parts. Inquire, also, whether the alleged violation took place during the menstrual period, or while the female was suffering from any relaxing discharge.

4. If there is any discharge observe its quantity, and collect a portion of it for examination: and proceed in the same way with spots of blood or semen found on the person or clothes.

5. If death have taken place, a complete examination must be made of the body and the internal viscera; search being made for bruises, fractures, or dislocations, and for foreign bodies thrust into the mouth.

6. Examine the spot on which the offence was committed.

Lastly. Examine the person of the accused; note his strength, and examine the parts of generation with a view to discover whether he be impotent, or capable of producing the existing amount of injury, whether he have the venereal disease, or any recent abrasion or rupture of the frænum. Examine his person also, with a view to discover bruises, scratches, or other marks of resistance; and his linen for spots of blood or semen.

If the joint examination of the complainant and accused do not support the charge of rape, it may justify the charge of assault with intent to commit it; and another indictment may be preferred, charging the prisoner with the misdemeanour.

PREGNANCY.

Medical examinations for legal purposes may be required not only in cases where pregnancy is truly alleged to exist, but where it is feigned or concealed.

Pregnancy may be *feigned* by the unmarried to extort money, to touch the feelings of a paramour or seducer, or to influence a jury in the assessment of damages for breach of promise; by the married, to gratify the wishes of a husband, or to produce a supposititious heir to an estate; and also, both by single and married, to stay the execution of capital punishment. Pregnancy may also be *concealed* both by married and unmarried, to avoid disgrace, to procure abortion, or to commit infanticide.

The most common occasions for examination arise at common law, when a widow, on the death of her husband, by alleging that she is with child, disappoints the heirs to the estate; and in criminal courts, when a woman condemned to death pleads pregnancy in stay of execution.

The legal procedure in the first case is by the issue of a writ *de Ventre inspiciendo*, the examination being intrusted to a *jury of matrons*, or discreet women, generally twelve in number, who, if they find the female pregnant, are charged with the duty of narrowly watching her till her delivery. In the second case, the duty of the jury is to ascertain, not only whether she is pregnant, but also whether she is *quick with child*.

This jury has not always been constituted in the same manner; and it is now a common practice to require the aid of skilled medical examiners. Thus in the case of Mrs. Fox,* two medical men and two matrons were appointed to visit her once a fortnight: and in a criminal case (Mary Weeks, indicted for the murder of George Weeks, Western Circuit, March 20, 1856), the counsel for the defence having moved for a stay of execution, as the prisoner was quick with child, the doors of the court were ordered to be locked, and a jury of matrons was called into the box, sworn, and charged to inquire into the fact. Two medical men were also sworn to examine the prisoner, and give evidence before the jury, who retired for a short time, and, on returning, found that the prisoner was in the condition alleged. Sentence was accordingly respited till the prisoner should be delivered.

A court of law has also interfered on proof of the pregnancy of a prisoner, application being made to admit her to bail. A case for medical examination may also arise under the act 1 Gul. IV., chap. 22, which provides that a deposition may be read in evi-

* 'London Med. Gaz.,' vol. xvi. p. 697; vol. xvii. p. 191.

dence when it can be shown to the satisfaction of the judge that a witness is unable, from permanent sickness or other infirmity, to attend the trial. It has been ruled that imminent delivery is a cause for examination under this act.

As the subject of pregnancy is one that involves many details, it will be examined under the following distinct heads:—1. *The signs and symptoms of pregnancy during life.* 2. *Examination of the uterus and its appendages after death, with a view to the discovery of proofs of an existing or previous pregnancy; and* 3. *Questions of a medico-legal nature connected with pregnancy.*

I. SIGNS OF PREGNANCY.

The leading Signs of Pregnancy are here briefly described, the reader being referred for more accurate information to works on midwifery, or to monographs treating expressly on this subject.*

Constitutional Signs or Symptoms.—An irritable and capricious temper, sadness and languor; a worn and dejected expression of countenance; nausea, heartburn, loathing of food, a capricious, variable, or depraved appetite; vomiting, especially in the morning, and a costive state of bowels; feverishness, determination of blood to the head, with eruptions on the face; and in some cases salivation, and pains of the face and teeth; are recognised symptoms of this state. Taken separately, they have little value, and even when several coexist, they are not conclusive.

The Breasts.—The changes in the breasts consist (*a*) in increased size and firmness; (*b*) in a moist dark circle, or areola, studded with mucous follicles formed round the nipple; and (*c*) in a mixed secretion of milk and serum flowing from the nipple.

The Uterus.—The signs referable to this organ are, *a.* changes in the size and shape of the abdomen; *b.* quickening; *c.* suppression of the menses; *d.* changes in the neck and orifice of the uterus; *e.* increased size; *f.* ballottement; *g.* discoloration of the mucous membrane of the vagina; *h.* sounds heard on applying the stethoscope to the abdomen.

a. Changes in the Size and Shape of the Abdomen.—These consist in a symmetrical enlargement, first perceptible about the end of the third month, and increasing up to the time of delivery. Before the third month the uterus sinking into the pelvis causes the abdomen to appear flattened, and the umbilicus depressed.

b. Quickening.—This is vulgarly attributed to the movements of the child, but is really due to a sudden change in the position

* Consult Montgomery, 'Cyclo. of Pract. Med.,' art. Pregnancy, and his 'Signs of Pregnancy.' Also Dr. Tanner's work on the same subject.

of the uterus, which usually takes place between the 14th and 18th weeks, but sometimes as early as the 12th. It is a very fallacious sign; for these movements may not be perceived at all, or they may be confounded with the motions of flatus, changes in the position of the viscera, or sudden contractions of the muscles.

c. Suppression of the Catamenia.—The menses may be suppressed for long periods, from causes other than pregnancy; or they may be present for one or two periods after conception, and even during the whole course of gestation; or, again, they may be absent at other times, and appear only after conception. Moreover, the sign is wanting in females who become pregnant without having menstruated. A woman who is really pregnant may also conceal the fact by pretending that she is regular, and imitating the catamenia by blood.

d. Changes in the Neck and Orifice of the Uterus.—The neck of the impregnated womb is full, round, soft, and elastic; the margins, or lips, lose their well-defined edge, and become soft, swollen, and indistinct; and in advanced pregnancy, the neck becomes shorter, and is at length no longer to be felt. The orifice, instead of being transverse, becomes circular, and admits the point of the finger more readily, and to a greater depth. The womb also shifts its position as pregnancy advances; it rises higher, the fundus is tilted forward, and the neck backward.

e. Increased Size of Uterus.—During the first three months, the womb not having yet risen out of the pelvis, no enlargement is discoverable even by examination per vaginam; but at the end of the fourth month it may sometimes be felt above the pubes; and during the fifth, both externally and per vaginam. As this gradual increase of size may obviously be due to causes other than pregnancy, it is not a sure sign of it.

f. Ballottement.—This is the name given to the sensation caused by the fall of the fœtus after it has been jerked upwards by a brisk movement of the finger. It is not available till after the fourth month, and rarely much beyond the end of the sixth. In practised hands it is a sign of great value.

g. Discoloration of the Mucous Membrane of the Vagina.—The mucous membrane of the vagina of the pregnant woman has a tint like that of lees of wine. This though an excellent sign of pregnancy, is inconvenient in application.

h. The Stethoscope.—Two sounds may be heard on applying the stethoscope over the region of the gravid uterus; *the pulsations of the fœtal heart*, and *the uterine murmur*. The *pulsations* of the fœtal heart vary from 120 to 160 in a minute, and bear no

relation to the pulsation of the mother. Each pulse is double, and resembles the tick of a watch heard through a pillow. It is not always heard in the same place, but generally on one side, at a point nearly midway between the navel and the anterior superior spine of the ilium; it is occasionally inaudible. When heard, it is a sure sign of pregnancy. It fails in the case of a dead fœtus, and is inapplicable at an early period of gestation. The *uterine murmur* is a low cooing sound, such as is made by blowing gently over the lip of a wide-mouthed phial. It is synchronous with the pulse of the mother, and may generally be detected in the lateral or anterior parts of the uterus, being first distinctly audible about the end of the fourth month.

The Urine.—A glistening scum (consisting of triple phosphate and minute fungoid and confervoid growths) is found floating on the urine of pregnant women, after standing one or two days; and under the name of *Kyestein* was once deemed a certain sign of pregnancy. Though generally present in pregnancy, it has been shown to occur also in anæmic women who are not pregnant. This, then, like the fact that the urine in pregnancy often contains grape-sugar, is of little value as a sign.

Of the foregoing signs few are conclusive when taken by themselves; while many are extremely fallacious, and are liable to be simulated by various diseased conditions, or to be obscured by co-existing diseases of the uterus, or of the abdominal viscera. The best of these signs can only be duly appreciated by experienced persons, to whom alone this class of inquiries should be intrusted.

Substances expelled from the womb sometimes furnish evidence of pregnancy. The chief of these are, 1. An early ovum. 2. Moles. 3. Hydatids. 4. False membranes.

1. *An Early Ovum.*—This may be recognised by the characters of the contained fœtus, and by that of its membranes. The appearances presented by the fœtus during the early stages of its development will be examined in the next chapter. The membranes present highly characteristic appearances. The decidua is known by its soft, rich, pulpy appearance and strong red colour, its rough external surface perforated by small foramina, and its smooth internal surface. The inner decidua is known by its smooth outer surface, and its internal one covered with the filaments that receive the arborescent villi from the surface of the chorion. These appearances are not assumed by any product of disease.

2. *Moles.*—Some authors regard these bodies as products of conception. If so, they will be identified as such by the discovery of some constituent parts of an ovum; but if no such parts

are found, it is right to assume that the substance under examination was not due to impregnation.

3. *Hydatids.*—There is a decided balance of opinion in favour of these being in all cases products of conception. It must be recollected, however, that Hydatids may spring from portions of membrane that have been retained for several months, so that they cannot serve to fix the date of the pregnancy.

4. *False Membranes.*—These are often expelled in dysmenorrhœa; and a careless observer might pronounce them products of conception. The rule already laid down, that no substance expelled from the womb should be deemed a product of conception, unless it contain constituent parts of an ovum, must be observed also in this case. For an illustration of a false membrane discharged during painful menstruation, see fig. 14, p. 81.

II. POST-MORTEM EXAMINATION.

This may be necessary, in order to determine the existence, or previous occurrence, of pregnancy.

The womb itself, by presenting the small size of the virgin state, may at once negative the supposition of pregnancy. Or it may be found enlarged, but empty, and marked by some of the changes that accompany gestation. In this case we should not be justified in asserting that pregnancy had existed, because these appearances may be due to any tumour which had distended the organ, and formed a vascular connection with its internal surface. If the womb is not found empty, its contents must be carefully examined, and if traces of an ovum should be discovered, the fact of previous impregnation would be made out.

Much importance was formerly attached to certain appearances in the *ovaries*, as signs of pregnancy; and on the trial of Mr. Angus, of Liverpool, for the murder of Miss Burns, a *corpus luteum* found in the ovary was held to prove the fact of recent pregnancy, in the face of much difference of opinion as to the conclusions to be drawn from the appearance of the womb itself.

The value of the *corpus luteum* as a sign of previous impregnation has been a subject of lively discussion, and the characters which distinguish the true corpus luteum, the product of conception, from the false, as found in virgins, have been very minutely described. It results from this discussion, that the distinction between the true and the false corpus luteum is not so marked and decisive as to justify us in making a confident use of it for medico-

legal purposes.* But between the corpora lutea of the adult virgin ovary, and those of the pregnant woman, the differences are such as ought to be pointed out and illustrated. Accordingly the following illustrations are appended from the able monograph of Dr. Arthur Farre.† Fig. 7 shows the longitudinal section of an adult virgin ovary, with Graafian follicles of ordinary size before enlargement, and stellate remains of follicles which have burst and shrunk after discharging their ova. In Fig. 8, 1, shows the section of an enlarged follicle, with central blood clot, from a woman who died on the tenth day after the commencement of her last menstruation; 2, the section of a large follicle which had recently burst and discharged its contents; while 3 and 4, show a superficial and a deeper section taken from the ovary of a woman who died at the end of the fourth month of gestation; and 5, the stellate follicle two days after mature delivery. The last three figures present appearances which may be deemed characteristic. They have "discharged an ovum, which has been afterwards impregnated." The question of prior pregnancy based on the appearance of the ovaries should always be submitted to some competent authority known to have carefully studied the subject.

Fig. 7.

Fig. 8.

* Casper states, as the result of his many post-mortem examinations, "that the corpora lutea found after pregnancy are not to be distinguished with any certainty from the corpora lutea, the result of the detachment of unfecundated ovula" (vol. iii. p. 360), and Kirkes (Physiology, 1st edit. p. 606) characterized as *unsafe* "all evidence of previous impregnation founded on the existence of a corpus luteum in the ovary."

† The Uterus and its Appendages, from the 'Cyclopædia of Anatomy and Physiology.' By Arthur Farre, M.D. Cantab., F.R.S.

III. MEDICO-LEGAL QUESTIONS.

These questions are—1. The limits of child-bearing? 2. Can a woman conceive while in a state of unconsciousness? 3. Can a woman remain ignorant of her pregnancy up to the time of delivery? 4. Does the presence of the hymen rebut the supposition of pregnancy? And 5. Is superfœtation possible?

1. *The Limits of Child-bearing.*—Cases of early fruitfulness are related by high authorities. Casper states generally that the commencement of the procreative power may be dated from the 13th to the 15th year, and its cessation from the 50th to the 52nd. (Vol. iii. p. 259.) The records of the Glasgow Lying-in Hospital contain a case of delivery at 15 years 1 month; and Montgomery delivered a female of twins before the completion of her 15th year. Dr. Wilson of Glasgow reports a case of delivery at 13½ years. Sir E. Home gives an instance of pregnancy in the 13th year; and La Motte a case of delivery before 13; the first-named author one in the 12th; Mr. Roberton a case of delivery of a still-born child in a factory girl little more than 12 years old; and Mr. Smith of Coventry one at 12 years 7 months; Bruce, in Abyssinia, and Dunlop, in Bengal, met with mothers of 11 years. Blumenbach gives an instance of pregnancy in a Swiss girl in her 9th year (Male, p. 176); Joubert and Schurigius cases at the same early age (Smith, p. 496); and we have it on the authority of Paris and Fonblanque that "in the year 1816 some girls were admitted into the *Maternité* at Paris as young as 13 years. During the Revolution one or two instances occurred of females at 11, and even below that age, being received in a pregnant state into that hospital."*

On the other hand, cases are recorded of pregnancy at very advanced ages. Bartholomew Mosse mentions four cases of women pregnant in their 51st year, and Dr. Labatt of Dublin one; Knebel, La Motte, and Roberton, each one in the 52nd year; Roberton one in the 53rd year; Bartholomew Mosse, Knebel, and Roberton each one in the 54th year; a case of pregnancy at the same age (that of Mrs. Ashley) is also related in the 'Edinburgh Annual Register' for 1816. In a French case, in which the succession to an estate was disputed on the ground of the mother being 58 when the child was born, a decision was given in favour of the fact. Pliny, Valescus de Tarenta, and Marra of Venice, record cases of pregnancy at 60. The Countess

* See a short paper by Dr. J. G. Wilson in 'Edin. Med. Journal,' October, 1861.

de Taxis is stated to have borne a healthy child at the age of 62 (Smith, p. 496). Capuron states that a woman of 63 was generally believed in Paris to have given birth to a daughter; and lastly, Beck quotes a case from the 'Boston Medical and Surgical Journal,' of a woman at Whitehall (State of New York) becoming a mother at 64.

It will be observed that at every age from 51 to 54 inclusive, several instances of pregnancy are recorded on undoubted authority. After this age there is a break in the chain, the earliest of the more remarkable cases having occurred at 58, and the latest at 64; and these were, for each age, solitary instances.

As the first and last appearance of the menses are usually supposed to fix the limits of possible fruitfulness, and as cases of early and late menstruation do certainly lend support to cases of early and late pregnancy, it may be well to state that menstruation at 9 years is not an uncommon occurrence in England or on the Continent. Male met with two instances of regular return of the catamenia and partial development of the breasts at six years of age. In one French case, menstruation is recorded at five years. The occurrence of the menstrual discharge, even in the first year of life, rests on good authority. Out of 1500 cases to which I directed my inquiries, I found one of menstruation before the completion of the eighth year. (G.)

On the other hand, I have known menstruation to continue uninterruptedly as late as the 57th year (G.); and Dr. James Reid recorded instances for every year from that age up to the 69th, inclusive. Cases of menstruation recurring, after interruption, at a still more advanced age are also on record.

As the age at which the menses first ap pear admits of medico-legal application, it may be well to state t hat the 14th and 15th years are the most common epoch of their commencement, then the 16th, then the 17th and 13th, then the 18th and 12th, and the other ages in the following order :—the 11th, 19th, 20th, 10th, 21st, 22nd, 9th, and 23rd. (G.)

The most common period for the disappearance of the menses would seem to be from the 45th to the 50th year, inclusive; but the instances before 40 and after 50 are numerous.

2. *Can a Woman conceive while in a state of unconsciousness?* —The answer to this question is affirmative. Capuron says, "It is a fact, which experience has more than once confirmed, that a woman may become with child while in a state of hysteria, under the influence of narcotics, during asphyxia, drunkenness, or *deep sleep*, and consequently without being conscious of it, or sharing the enjoyment of the man who dishonours her." This

statement is fully borne out by a case given by Capuron himself, in which the unconscious intercourse took place during a profound sleep produced by punch; by a case cited by Beck, Art. Pregnancy, in which the same result was brought about by wine; and by a third case communicated to Foderé by Desgranges, in which opium was administered with the same intent.

As examples of conception following intercourse during profound sleep, two cases may be cited, the one on the authority of Dr. Gooch, the other on that of Dr. Cusack. Of unconscious intercourse followed by pregnancy during a prolonged fainting fit, an instance was communicated to me by Mr. Hewitt of Berkshire (G.); and of violation with the same result during asphyxia, or apparent death, an instance is cited by Foderé (vol. i. p. 500) from the 'Causes Célèbres.'

There are, therefore, various conditions of insensibility, during which connection may take place followed by conception, the female being unconscious of the occurrence, and not suspecting it afterwards.

3. *Can a Woman remain ignorant of her Pregnancy up to the time of Delivery?*—It is obvious that in the cases just referred to this is quite possible. A woman who is not conscious of having exposed herself to the risk of becoming a mother, would naturally attribute her enlargement, and all the attendant symptoms, to any cause but the true one. A like ignorance is perhaps possible when a female yields to solicitation under solemn assurances that, in certain circumstances, connection may take place without danger. Thus Foderé, on the authority of Desgranges, cites the case of a young girl who yielded to the solicitations of her lover, and had connection with him in a bath, under the assurance that in that situation she ran no risk. She became a mother, but seemed to remain ignorant of her situation till the last, and assured Desgranges that the circumstance of the intercourse having taken place in the water had removed all idea of pregnancy.* An opinion also prevails that a single coitus is unattended with danger; and that provided the act be incomplete, and the hymen uninjured, impregnation is impossible. Foderé also refers to cases in proof of the confidence placed by pregnant women in the precautions they had taken.

In all such cases it is possible, though unlikely, that a female may attribute her symptoms to disease, and really believe what

* Foderé, vol. i. pp. 496-7. Beck quotes this case as illustrating the position that ignorance of pregnancy may exist "when the female is an idiot." But though Desgranges describes the girl as "assez niaise," there seems no good reason to regard her as an idiot.

she so much desires should be true, the wish in this, as in other things, being father to the thought; and as the married woman, anxious for offspring, construes every unusual sensation into a sign of pregnancy, and makes serious preparations for the event which is to crown her wishes, so the single woman, whose wishes all tend the other way, may sincerely attribute to any cause but the true one, every symptom of a state which threatens her with exposure. But even married women who have no motive to misunderstand or misrepresent their true condition, may, up to the very last, attribute it to a wrong cause. The conditions under which this is most likely to happen are such as occurred in a case reported by Dr. Tanner. A lady 42 years old, and married three years, after menstruating scantily for five or six months previously, had ceased to be unwell for about nine months, was taken in labour and delivered by instruments of a mature female infant. Both parents, though anxious for children, despaired of having them, and the lady had no suspicion that she was pregnant, and received with unaffected incredulity the statement that she was not only in that state, but had been in labour for ten hours.*

But perhaps the most remarkable instance on record of pregnancy ignored, if not by the female herself, at least by those most likely to suspect her, was furnished by the Hawkins' divorce case tried before the House of Lords, May, 1852. The husband, after an absence of ten months from England, rejoins his adulterous wife, cohabits with her for more than two months, and even sleeps with her up to within five minutes of her delivery—a circumstance the more extraordinary as he had already cohabited with her during two previous pregnancies. Nor was the true state of the case suspected by any of her friends and acquaintances, by her maid who had dressed and undressed her up to the night of her confinement, or by her medical men, the alteration that had taken place in her personal appearance having been uniformly attributed to illness. Indeed, it was by medical advice that she remained in England while her husband served abroad. Singular as the facts of the case were, the Lord Chancellor expressed his belief that the petitioner was wholly unconscious of his wife's state till she gave birth to the child.

4. *Does the presence of the Hymen rebut the supposition of Pregnancy?*—This question is anwered by the facts quoted at p. 48, proving that the hymen may survive repeated intercourse, and not be destroyed even by delivery.

5. *Is superfœtation possible?*—This question is discussed under the head of Legitimacy, to which it properly belongs.

* A Case of Unsuspected Pregnancy and Labour. By Thomas Hawkes Tanner, M.D.: 'Trans. of the Obstetrical Society of London,' vol. iv. 1863.

DELIVERY.

Delivery, like pregnancy, may be concealed or pretended;—concealed, with a view of hiding shame, or destroying the child; pretended, in order to produce a supposititious heir to an estate, to bring about a marriage, or to satisfy the wishes or appease the anger of a husband.

The medical man, then, may be required for medico-legal purposes to ascertain the existence of delivery in concealed cases, and its non-existence in pretended cases. The latter class is comparatively rare; but the former is of frequent occurrence, especially in accusations of infanticide, when the suspected mother has to be examined to determine whether she has been recently delivered. A similar inquiry may be called for in the dead. It may also be necessary to determine whether a female has borne children at a former period. And a question may be raised (especially in trials for infanticide) as to the possibility of a woman being delivered while unconscious, or in such a position and in such circumstances as, without any criminal act of her own, to endanger the life of her offspring.

This subject, therefore, resolves itself into four divisions:—1. *The signs of recent Delivery in the Living.* 2. *The signs of recent Delivery in the Dead.* 3. *The signs of a previous Delivery.* 4. *Other medico-legal questions connected with Delivery.*

I. SIGNS OF RECENT DELIVERY IN THE LIVING.

When an examination is made within a few days after delivery, the following appearances are present:—The *face* is pale, as in one recovering from a slight illness, and the eye sunken, and surrounded by a dark circle. The pulse is quickened, and the skin, soft and warm, is moistened with sweat of a peculiar and unpleasant odour. The *breasts*, especially on the third or fourth day, are found full, tense, and knotty. The nipples are turgid, and the areola presents the appearances proper to the state of Pregnancy. The breasts when pressed or drawn yield a milky fluid, which presents microscopic characters of some practical value in connection with delivery as well as with infanticide. For the first five or six days after delivery, the fluid that may be expressed from the breasts is more watery and opalescent than ordinary milk, and less white and opaque. Under the microscope, along with the ordinary milk globules there occur epithelium, and the compound granular corpuscles known as *colostrum corpuscles*. The figures annexed compare the *colostrum* from a healthy woman 12 hours after delivery (fig. 9), with the milk of another

healthy woman after the lapse of a week* (fig. 10). The *abdomen* is distended, its integuments are relaxed and thrown into folds, and its lower part, from the pubes to the navel, marked by light-

Fig. 9.

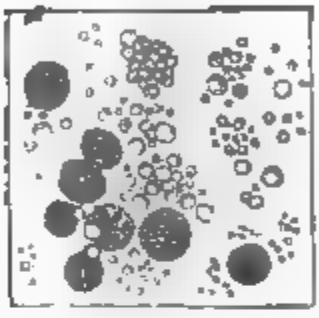
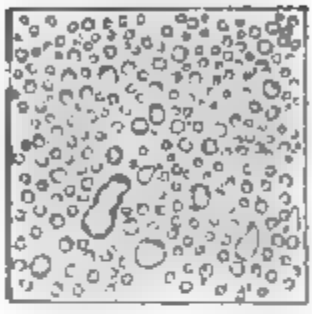


Fig. 10.



coloured broken streaks or cracks. On pressing the hand firmly over the pubic region, the imperfectly contracted uterus is felt about the size of the head of a new-born infant, rising three or four inches above the brim of the pelvis, and inclining more to one side than the other. The *external parts of generation* bear distinct marks of distension and injury. They are swollen and relaxed, and not uncommonly bruised and torn. After a first labour, the fourchette is often ruptured, and the injury sometimes extends deep into the perineum. On examination *per vaginam* the *uterus* is found enlarged, and corresponding with the external tumour, the os uteri gaping, so as to admit two or three fingers, and its margins relaxed, flabby and fissured. If the examination is made within a few hours of delivery, the orifice is so open that its margin cannot be distinguished, and it seems a continuation of the vagina. The vagina itself is also dilated and relaxed, and its inner surface smooth from the obliteration of the rugæ. At the time of delivery much pure blood escapes from the torn vessels of the womb, and for the first two or three days, but sometimes much longer, a bloody discharge (*the lochia*) flows from the genitals. This, when no longer mixed with the blood first discharged, is found to be destitute of fibrin, though rich in blood-corpuscles, various epithelium scales, pus-cells, and fatty globules. It then, for about the same length of time, becomes nearly colourless, or acquires a light brown or dirty greenish hue, whence the vulgar name "green waters," and has a peculiar sour odour, resembling that of fish-oil—an odour very difficult to conceal or destroy. This is succeeded by a milky mucous discharge, which continues for four or five weeks.

The value of these signs depends upon their being found in

* After 'Day's Physiological Chemistry,' Plate 5.

combination. The uterus and vagina may be enlarged, and the external parts distended by any tumour recently expelled. A discharge may flow from the genitals, and the breasts may enlarge and secrete milk, from sympathy with the distended uterus. The abdomen, also, may display all the marks of recent distension.

The examination should be made without delay; for the signs may disappear before the tenth day; and, as a general rule, no satisfactory results are to be expected after that date. It may even be difficult to give a decided opinion before this period has elapsed, epecially if the fœtus be small and the mother vigorous.

In cases of early abortion, the appearances are slight and evanescent, and before the end of the second month no evidence of recent abortion would be discoverable.

II. SIGNS OF RECENT DELIVERY IN THE DEAD.

The external parts have the same appearance as in the living. On opening the abdomen, the uterus is found to present different appearances, according to the time that elapsed between delivery and death. If death has taken place immediately after parturition, the os uteri will be found wide open, and the womb itself flat and flabby, from 9 to 12 inches long, its cavity containing large clots of blood, its inner surface lined by the soft and pulpy remains of the decidua, and the attachment of the placenta distinctly visible, characterized by the dark colour, the small number of flocculi, and the semilunar openings on its surface.

The size of the womb at periods more remote from delivery varies with the degree of contraction. In the first two or three days after the delivery of a mature child, it is about seven inches long by four broad; its external surface is vascular, and marked by purple patches; and when divided it is found to be from an inch to an inch and a half thick, of the colour and consistence of firm muscular fibre. Its internal surface retains the appearances just described. At the end of a week it is between five and six inches long and about an inch thick; less vascular, but more firm. The inner surface is still bloody, and partially covered by decidua. At the end of a fortnight the length does not exceed five inches, and after the lapse of a month, it has resumed its original size, but the os uteri never closes so completely as in the virgin state. The Fallopian tubes and one or both of the ovaries are found turgid and vascular, and on being cut into present one or more corpora lutea.

III. SIGNS OF A PREVIOUS DELIVERY.

The external marks consist of silvery lines, or "shining broken streaks, like the remains of cracks," on the skin of the breasts and

abdomen, and especially in the groins. These marks are often absent, and when present merely indicate great previous distension followed by sudden subsidence. The marks on the abdomen are, for obvious reasons, the most fallacious; but those on the breasts are very unlikely to be caused by any other form of distension. When the two coexist they furnish strong evidence either of a former delivery, or of some distension of the womb producing sympathetic enlargement of the breasts. An experienced hand will detect in the os uteri a peculiar, jagged condition, on which much stress has been laid. The marks of a previous rupture of the fourchette or perineum would also afford confirmatory evidence. On the other hand, we may find decisive negative evidence in a state of imperforation or narrowness quite inconsistent with either pregnancy or delivery. A perfect hymen would also afford a presumption against a previous delivery. (See p. 48.) The following case illustrates the difficulty that may exist of proving the fact of a previous delivery:—"We very lately examined a patient who had borne five children, and nursed three of them, the youngest being now five years old; the breasts were small, but neither flaccid nor pendulous; the nipples short, with not the least shade of brown colour in the areolæ, which exhibited only the delicate rose colour so often observed on that part of the virgin breast; there were neither lines nor spots of any kind on the abdomen; the os uteri was small and natural; the vagina contracted, and the fourchette perfectly entire. It should be mentioned that this lady never carried her children beyond the end of the eighth month."*

4. *Other Medico-legal Questions connected with Delivery.*—Two such questions still remain to be examined. 1. Can a woman be delivered in a state of unconsciousness? 2. Can a woman, if alone and without assistance, prevent her child from perishing? The first of these questions will be examined in this place; the second belongs to the subject of Infanticide.

Can a woman be delivered in a state of unconsciousness? This question can be answered in the affirmative. The event may happen under the influence of narcotics or ardent spirits; and during coma, delirium, or puerperal convulsions, attacks of apoplexy, deep sleep, and suspended animation. Cases of unconscious delivery are not likely to happen in a female pregnant for the first time; but in women who have borne many children, and have easy deliveries, such an event is more probable.

* Montgomery: 'Cyclo. Pract. Med.,' vol. iv. p. 504.

CHAPTER III.

FŒTICIDE. INFANTICIDE. LEGITIMACY.

THESE subjects cannot be understood without a preliminary knowledge of the growth and development of the Embryo and Fœtus.

GROWTH AND DEVELOPMENT OF THE FŒTUS.

It used to be asserted that a distinct ovum containing a defined embryo cannot be discovered in the womb before the 20th or 22nd day; but Velpeau* saw three ova not more than twelve days old, and Sir E. Home found a very minute ovum in the womb only eight days after impregnation.† The following account of the development of the embryo is based chiefly on the description of Devergie,‡ with the estimates of length and weight given by Hamilton, Burns, Capuron, Chaussier, Maygrier, Foderé, Orfila, Devergie, and Velpeau, and Bichard's measurements of the fœtal skeleton; the French measures and weights being reduced to the English standards.

Embryo, Three to Four Weeks.—Length, about $\frac{1}{3}$ inch. *Weight*, about 20 grains. *Size*, that of a large ant, or a barley-corn. *Form*, that of a serpent, the head indicated by a swelling, the caudal extremity slender, and ending in the umbilical cord; the mouth indicated by a cleft; the eyes by two black points; the members appearing as nipple-like protuberances. The villosities of the chorion uniformly spread over the surface.

Six Weeks.—Length, from half an inch to less than an inch. *Weight*, from 40 to 75 grains. The head distinct from the chest, and the face from the cranium, and the apertures of the nose, mouth, eyes, and ears perceptible; the hands and forearms in the middle of the length, and the fingers distinct; the legs and feet situate near the anus; a distinct umbilicus for the attachment of the cord, which consists of the omphalo-mesenteric vessels, of

* 'Embryologie,' p. 50. † Gooch's 'Midwifery,' p. 88.
‡ 'Médecine Légale,' art. Infanticide.

part of the urachus, of the intestinal tube, and of filaments which represent the umbilical vessels. The placenta forming; the chorion and amnion still separate; the umbilical vessel very large. *Points of ossification* in the clavicle and maxillary bone.

Two Months.—Length, variously stated at from 1½ inch to 4 inches. *Weight*, 2 to 5 drachms. Rudiments of nose, lips, and eyelids; organs of generation visible: arms and legs detached from trunk; anus marked by a dark spot; rudiments of lungs, spleen, and supra-renal capsules; cæcum behind the umbilicus; digestive canal withdrawn into the abdomen; urachus visible; chorion beginning to touch the amnion at the point opposite the insertion of the placenta, which begins to assume its regular form; umbilical vessels becoming twisted. *Points of ossification* in frontal bone and ribs.

Three Months.—Length, variously stated at from 2 to 6 inches. *Weight*, from 1 ounce to 3 ounces. The head voluminous; the eyelids and lips in contact; membrana pupillaris visible; fingers separated; lower extremities longer than rudimentary tail; parts of generation prominent, and the sex distinguishable by the lens; thymus and supra-renal capsules present; the ventricles of the heart distinct. The decidua uterina and reflexa in contact; the funis containing umbilical vessels and a little gelatinous matter; placenta completely isolated; the umbilical vesicle, allantois, and omphalo-mesenteric vessels have disappeared.

Four Months.—Length, variously stated at from 4½ to 8½ inches. *Weight*, 2½ or 3, to 7 or 8 ounces. Skin rosy, and tolerably dense; mouth very large and open; membrana pupillaris very evident; nails appearing; sex distinct; gall-bladder appearing; meconium in duodenum; cæcal valve visible; umbilicus near the pubes. Complete contact of chorion and amnion; membrane forming at point of attachment of placenta to uterus. *Points of ossification* in inferior parts of sacrum; ossicula auditoria ossified.

Five Months.—Length, variously stated at from 6 to 10½ inches (a still-born male 13, female 13½; male born alive 9, female 10, inches). *Weight*, 5 or 7 ounces to 1 pound 1 ounce. (A still-born male, 1 pound 13 ounces [Schmitt]; two still-born twin females, 1 pound 6 ounces, and 11 ounces [G.]). Volume of head still comparatively great; nails very distinct; hair of the head showing as a light down; skin without sebaceous covering; heart and kidneys very voluminous; gall-bladder distinct; meconium of a yellowish-green tint at commencement of large intestines. *Points of ossification* in pubes and os calcis; germs of the permanent teeth.

Six Months.—Length, variously stated at from 8 to 13½ inches. *Weight*, 1 lb. to 2 lbs. 2 oz. Skin has some appearance of fibrous structure, and is covered with down and sebaceous matter; the body of the colour of cinnabar; eyelids still adherent; membrana pupillaris still existing; funis inserted a little above the pubes; meconium in upper part of large intestines; liver of dark-red colour; gall-bladder contains insipid serous fluid; testes near kidneys. *Points of ossification* in the four divisions of the sternum. Middle point of body at lower end of sternum.

Seven Months.—Length, variously stated at from 11 to 16 inches. *Weight*, 2 lbs. to 4 lbs. 5 oz. Skin dusky red, thick and fibrous, and covered with sebaceous matter; hair about ¼ inch long; nails not reaching to ends of fingers; eyelids no longer adhering; membrana pupillaris disappearing; meconium occupying nearly all the large intestine; left lobe of liver almost as large as right; gall-bladder containing bile; brain firmer; testicles more distant from kidneys. *Point of ossification* in the astragalus. Middle point of body a little below the sternum.

Eight Months.—Length, 14 to 18 inches. *Weight*, 3 lbs. 4 oz. to 5 lbs. 7 oz. Skin rosy, covered with fine short hairs, and with well-marked sebaceous envelope; nails reaching ends of fingers; membrana pupillaris has disappeared; testicles descend into the internal ring. *A point of ossification* in the last vertebra of the sacrum. The middle point of the body nearer the umbilicus than the sternum.

Nine Months, or Full Term.—Length, 16 to 20 inches. *Weight*, 4 lbs. 5 oz. to 7 lbs. The head covered with hair about an inch long; skin coated with sebaceous matter; the down absent, except about the shoulders; testes have passed inguinal ring, and are often found in scrotum; meconium at termination of large intestine. *Point of ossification* in centre of cartilage at lower end of femur; os hyoides not ossified; four portions of occipital bone distinct; external auditory meatus cartilaginous.*

* Casper attaches the utmost importance to the state of the ossification in the lower epiphyses of the femur, as a means of determining the degree of maturity of the fœtus; and as the test is applicable when only a skeleton is found, it may stand us in stead when all other signs are wanting.

Though no other long bone exhibits the slightest appearance of ossification in the last, or tenth lunar month, of gestation, in the second half of that month an ossific point appears in the lower epiphysis of the femur. This is shown by cutting into the knee-joint, and then taking successive slices of the cartilage till the greatest diameter is reached. A coloured point thus becomes visible in the milk-white cartilage, in the form of a more or less circular light blood-red disc, much harder than the surrounding tissue. In decomposed

As the growth and development of the fœtus has an important bearing on the subjects of this chapter, and the estimates just given are obviously too general, I have prepared two tables founded on the accurate observations of different authors, and presenting not only the average weights and measures, but the two extremes; for it is obvious that the extreme values which have hitherto been so much neglected in all numerical investigations, are often those most needed. (G.)*

Of the following tables, the first (p. 77) presents the ascertained weight of the fœtus at the several ages specified, the second (p. 78) the ascertained length. In both tables the still-born are distinguished from those born alive: among the latter those only being included who had survived their birth one week or less. The foreign weights and measures have been reduced to the English standard, fractional parts of an ounce being omitted. The number of observations is stated, in order that the value of the results may be better appreciated, and that fresh observations may at any time be added.

The weight of the fœtus at full term has been made the subject of many investigations, and as it is important in itself, and interesting as throwing light on the probable limits of variation at earlier periods of gestation, the results, as deduced from upwards of 20,000 observations, by Quetelet, Camus, Lécieux, and Baudelocque, and by Drs. Macaulay and Clark, including the facts in the table, are subjoined:—

Greatest 14 lbs.; least, 2 lbs. 6 oz.; average, 6 lbs. 11 oz.

Weights have been recorded greatly exceeding even this maximum. Dr. Merriman gives one exceeding 14 lbs.; Sir Richard Croft one, and Dewees two, of 15 lbs.; Dr. Ramsbotham, senior, and Dr. Moore of New York, instances of 16½ lbs.; and Mr. Owens, of Ludlow, one of 17 lbs. 12 oz. Even this great weight is said to have been exceeded.

bodies, however, the cartilage is of a pale dirty-yellow tint, and the ossific point a dusky red. Casper states, as the result of 464 examinations, that if this point is not seen the fœtus cannot be older than 36-37 weeks. When this point is not seen in mature infants (and this happens in one case out of 34) its absence coincides with defective organization, and retarded development in other respects also. The commencement of the ossification, when the size of the ossific point is that of a hemp seed, or of the head of a fly (half a line) indicates an age of 37-38 weeks. In the rare cases in which it has this small size at full term, there is defective development elsewhere. A diameter of from ¾ to 4 lines, indicates maturity; and we can conclude, almost certainly, that the infant has survived its birth if the ossific point exceeds 4 lines, or a third of an inch in diameter. Casper has seen no exception to this rule; but on the other hand, a less diameter than 3 lines, or a quarter of an inch, is consistent with an infant having survived its birth.

* A large collection of facts and figures relating to the growth and development of the fœtus will be found in Casper's Handbook, vol. iii. p. 18 et seq.

Greatest, Least, and Average Weights of the Fœtus at different periods of Utero-gestation.*

[illegible]	Six Months.			Seven Months.			Eight Months.			Nine Months.		
	Still-born.	Born alive.	Both.	Still-born.	Born alive.	Both.	Still-born.	Born alive.	Both.	Still-born.	Born alive.	[illegible]
	4, 8, 12, obs.	7, 11, 18, obs.	11, 19, 30, obs.	16, 19, 36, obs.	20, 18, 43, obs.	36, 38, 79, obs.	20, 18, 43, obs.	31, 23, 57, obs.	51, 40, 100, obs.	70, 58, 143, obs.	135, 89, 245, obs.	205, 146, 391, obs.
	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
Male max.	2 14	2 10	2 10	4 12	6 2	6 2	7 5	7 15	7 15	13 11	11 15	13 11
Male min.	1 9	0 14	0 14	2 0	1 9	1 9	2 13	2 2	2 2	2 6	2 8	2 6
Male mean	2 5	2 1	2 2	3 10	3 7	3 8	4 11	4 2	4 5	7 5	6 0	6 8
Female max.	3 13	2 16	3 13	5 4	5 5	5 5	6 4	7 7	7 7	12 7	14 0	14 0
Female min.	0 14	1 4	0 14	1 5	2 4	1 5	2 2	1 15	1 15	3 15	2 12	2 12
Female mean	2 1	2 3	2 2	3 6	3 9	3 8	4 3	4 6	4 5	7 6	5 8	6 4
Male and Female max.	3 13	2 16	3 13	5 4	6 2	6 2	7 5	7 15	7 15	13 14	14 0	14 0
Male and Female min.	0 14	0 14	0 14	1 5	1 9	1 5	2 2	1 15	1 15	2 6	2 8	2 6
Male and Female mean	2 1	2 2	2 2	3 8	3 7	3 8	4 7	4 4	4 5	7 5	6 1	6 8

* This table is founded upon 293 observations by Lécieux, 93 by Schmitt, 74 made under the direction of Bernt, 17 by Orfila, 16 by Devergie, 19 by Haartmann, 11 by Joerg, 30 by Dr. Taylor (of which a large proportion are contributed by Dr. Geoghegan of Dublin), and 17 by the author. Smaller numbers of facts have been borrowed from Jäger, Mörrike, Dr Brady, and others. For exact references to the authors, see 'Ed. Med and Surg. Journal,' Nos. 140 and 160. One case in which the weight at six months amounts to 5 lbs. 1½ oz. is omitted from the table, as the figures are obviously too high, and must be considered as originating in an error or misprint.

Greatest, Least, and Average Lengths of the Fœtus at different periods of Utero-gestation.*

SEX.		Six Months.						Seven Months.						Eight Months.						Nine Months.					
		Still-born.		Born alive.		Both.		Still-born.		Born alive.		[illegible]		Still-born.		Born alive.		Both.		Still-born.		Born alive.		[illegible]	
		3, 2, 5, obs.		2, 2, 4, obs.		5, 4, 9, obs.		7, 9, 16, obs.		10, 9, 22, obs.		17, 18, 38, obs.		10, 6, 17, obs.		13, 8, 26, obs.		23, 14, 43, obs.		47, 35, 82, obs.		57, 32, 89, obs.		104, 65, 181, obs.	
		in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.
Male	max.	14	6	14	0	14	0	16	7	17	3	17	3	19	0	19	9	19	9	22	11	23	6	23	6
	min.	10	6	14	0	10	6	11	11	12	6	11	11	16	0	14	9	14	9	16	7	17	1	16	7
	mean	12	11	15	6	14	0	14	7	15	5	15	1	17	7	17	0	17	3	20	0	19	6	19	9
Female	max.	16	1	14	6	16	1	16	7	16	6	16	7	18	8	17	10	18	8	22	4	24	0	24	0
	min.	12	10	14	0	12	10	13	0	12	6	12	6	16	7	15	6	15	6	17	0	16	6	16	6
	mean	14	5	14	3	14	4	15	1	14	2	14	7	18	1	16	7	17	2	19	9	19	5	19	7
Male and Female	max.	16	1	14	6	16	1	16	7	17	3	17	3	19	0	19	9	19	9	22	11	24	0	24	0
	min.	10	6	14	0	10	6	11	11	12	6	11	11	16	0	14	9	14	9	16	7	16	6	16	6
	mean	13	7	14	11	14	2	14	10	14	11	14	11	17	8	16	11	17	2	19	11	19	4	19	7

* This table is founded upon 271 observations, of which 98 were by Schmitt, 70 were made under the superintendence of Borst, 26 by Devergie, 17 by Billard, 21 by Dr. Taylor (including those contributed by Dr. Geoghegan), and 24 by the author. A few scattered measurements made by Orfila, Madame La Chapelle, &c., complete the number. One instance of 17 in. 1 lin. at the sixth month, and another of 9 in. 10 lin. at the seventh month, are omitted from the table, as being greatly above and below all the other figures for the same ages.

N.B.—It will be observed that the number of observations given in the second line at the head of these tables does not always correspond to the sums of the previous figures. This arises from the introduction of the weights and measures of children of which the sex was not stated.

The following is the length of the fœtus at full term, as given by different English and French authors :—

Greatest, 26 inches; least 17 inches; average, 19 inches.

But in certain cases the length has exceeded even this maximum. Dewees, for instance, met with a length of 27 inches.

It may be well to add that, as a rule, still-born infants are heavier and longer than those born alive, males than females, single children than twins, and twins than triplets.

The signs of maturity and immaturity will be gleaned from the foregoing account of the development of the fœtus; and they will be stated more fully under the head of legitimacy.

FŒTICIDE, OR CRIMINAL ABORTION.

The crime of abortion consists in unlawfully administering to any woman, or causing to be taken by her (whether she be with child or not), with intent to procure her miscarriage, any poison or other noxious thing, or using for the same purpose any instrument or other means whatsoever; also in the use of the same means with the same intent by any woman being with child (24 & 25 Vict. cap. c. § 58, 59). The statute is silent as to the distinction between women *quick* and *not quick* with child.

The first duty of the medical examiner is to establish the fact of abortion by examining any substances that may have been expelled from the womb. Having ascertained that they are products of conception, he may be required to determine whether the abortion was due to natural causes, to drugs, or to violence. In rare instances, too, he may have to examine the female in whom the abortion is alleged to have taken place, in order to determine whether or not she has been recently delivered. Three different examinations therefore may be required.

1. An examination of substances expelled from the womb.
2. An inquiry into the cause of the abortion; and
3. An examination of the female supposed to have miscarried.

1. *Substances expelled from the Womb.*—It is only in the early periods of gestation that this examination will offer any difficulty. When the embryo has attained a certain degree of development, its appearance is quite characteristic. The rule already laid down (p. 63), in speaking of moles and false membranes as signs of pregnancy, must be observed in cases of alleged abortion, viz. to admit no substance to be a product of conception in which distinct traces of an ovum cannot be recognised. To this rule hydatids form a solitary exception.

The annexed figures from Hunter's 'Gravid Uterus,' show the

appearance of early ova, in contrast with that of a false membrane discharged in dysmenorrhœa. Fig. 11 exhibits a complete ovum of about three weeks, with bristles A B, A B, traversing the cavity, from the angles A, A, corresponding to the Fallopian tubes to the point opposite the neck of the uterus. Fig. 12 shows the same ovum with much of its anterior wall cut away. A small hydatid which complicated the figures unnecessarily has been omitted. The two figures are reduced to about two-thirds of the original. Fig. 13 shows an ovum of about eight weeks, consisting of the chorion and its contents, without the decidua. The size of the figure is the same as in the original. Fig. 14 represents a portion of the lining membrane of the uterus cast off during painful menstruation. It presents all the characters of a true decidual structure, having on the side which corresponded with the uterine cavity a fine cribriform surface, and on the reverse side the rough flocculent appearance characteristic of the outer surface of membranes ordinarily discharged, along with the ovum, in abortion.

Fig. 11.

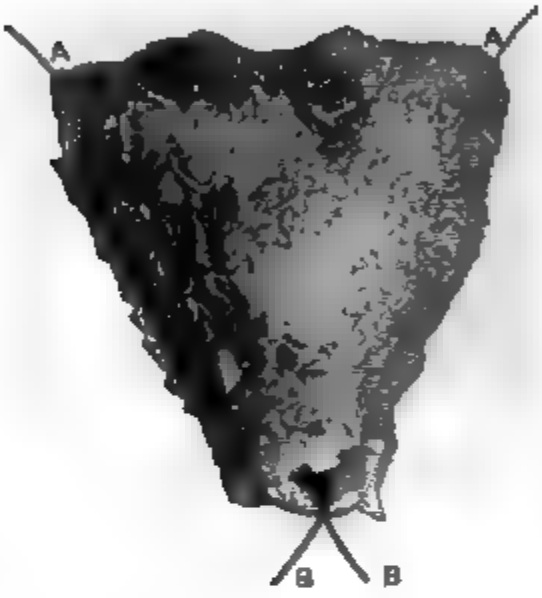
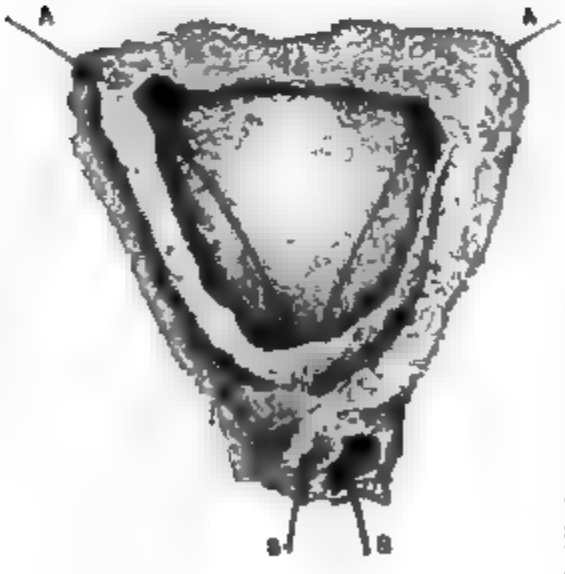


Fig. 12.



Having ascertained that the substance submitted to our inspection is really a product of conception, we must

next determine its age by comparing it with the description already given of the growth and development of the embryo and fœtus, p. 73 et seq.

Fig. 13.

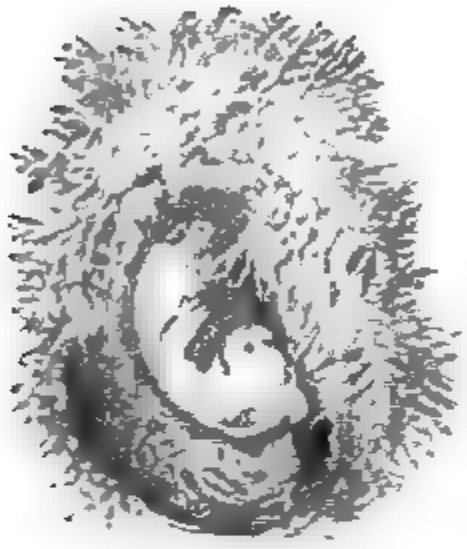


Fig. 14.

2. *Cause of the Abortion.*—In considering the cause of an abortion attributed to drugs or force, it is necessary to be armed with some preliminary knowledge respecting the occurrence of abortion from natural causes. This is known to be very common, especially in the early months, and it has been variously stated as occurring in 1 out of 12, or even (Dr. Granville) 1 in 3 of the total number of conceptions. Accoucheurs who have had to deal chiefly with women in more advanced periods of pregnancy have estimated the proportion much lower (*e.g.*, 1 in 188, Madame La Chapelle). The causes of these miscarriages will be conveniently considered under the title of

Natural Causes.—These are either (*a*) *predisposing*, or (*b*) *exciting*. *a*. The *predisposing* causes may affect either the female herself or the ovum. The females most liable to abortion are the plethoric, the irritable, the nervous, the lymphatic, the feeble, and the ailing; also those suffering from excessive or irregular menstruation and leucorrhœa; from syphilis, scurvy, asthma, and dropsy, and from malignant diseases. Malformations of the pelvis, its small size in those who marry very early, tight lacing, and all diseases of the womb or its appendages which restrain the complete development of the organ, also act as predisposing causes.

To these may be added, rigidity of the womb in those pregnant for the first time at a mature age, and a relaxed condition of the neck. Occasionally, abortion has been epidemic.*

The predisposing causes dependent on the state of the ovum are very numerous, especially in the early months. According to Velpeau, of upwards of 200 embryos expelled before the end of the third month, at least one half were diseased. The disease may be in the membranes, in the placenta, or in the fœtus itself; and it may assume any form of structural degeneration. Disease of the fœtus, or its annexes, affords, of course, a strong probability in favour of abortion from natural causes.

A woman who has once miscarried is likely to miscarry again from the same cause, and at or about the same period of gestation; and it is usual to attach some importance to the mere force of habit. In a case given by Heberden ('Commentaries,' p. 15), there were no less than 35 miscarriages.

b. To the *occasional*, or *exciting* causes, belong strong and sudden actions of the muscles of the abdomen, as in coughing, straining efforts to void urine or fæces, &c.; violent exercise, as in dancing; profuse discharges from the bowels or from the womb itself; undue excitement of the genital organs; blows, and various forms of mechanical injury.

All these occasional or exciting causes fail to produce abortion when the ovum is sound and the female healthy; but the most careful abstinence from all exciting causes will not prevent abortion when the predisposition from either cause is strong.

The *criminal means* are best divided into two classes, *general* and *local*; the first acting through the constitution of the mother, the second by immediate application to the abdomen or uterus.

1. *General, or Constitutional. Venæsection.*—The confidence placed by the vulgar in this remedy rests, like many other popular fallacies, on high medical authority—that of Hippocrates. But it is a notorious fact that pregnant women bear blood-letting well, and that it is often the best means of averting a threatened abortion. The assumption that blood-letting promotes abortion is moreover rebutted by numerous well-attested facts. Cases are recorded of women bled 48, 80, and 87 times in the course of their pregnancies, without miscarriage; and Dr. Rush, who bled very freely in the yellow fever of 1793, asserts that not one pregnant woman to whom he prescribed bleeding died or miscarried.

The popular belief in the efficacy of bleeding from the foot

* See references to such epidemics in Velpeau's 'Art des Accouchemens,' art. Avortement.

rests on no better foundation, nor does the removal of blood by *leeches* to the *anus* or *vulva*—a practice rarely resorted to in this country—possess any peculiar efficacy.

Emetics.—It is well known that during the early months of pregnancy, and even in some instances throughout its entire duration, severe and distressing vomiting occurs, without producing abortion. This fact, coupled with the failure of several active irritant poisons productive of violent vomiting to cause miscarriage, affords some presumption against the efficacy of emetics, except in women strongly predisposed.

Cathartics.—These remedies, too, may be given repeatedly, and in very large doses, without producing abortion, except, as before, in women strongly predisposed. Dr. Rush's experience in the yellow fever of 1793 is conclusive on this point.*

Diuretics.—These remedies are mentioned as calculated to produce abortion, but without sufficient reason. Irritant poisons, which act in moderate doses as diuretics (*e.g.*, nitre), may occasion abortion; but not simply by their diuretic action.

One of the irritant poisons specially deserves notice in this place: namely, *cantharides*. It is a strong emetic and purgative, and an effective diuretic, acting violently on the organs in the immediate neighbourhood of the womb, viz., the bladder and rectum, occasioning also intense fever and great weakness; and yet even this drug in full doses may fail (as in a case related by Mr. Lucas, of Leeds). The frequent failure of such active poisons renders the efficacy of less powerful remedies extremely doubtful, where there is no decided predisposition to miscarry.

Emmenagogues.—Under this name a vast number of active and inert remedies are classed, most of which have as little effect on the womb as on other parts of the body. *Savin*, *mercury*, *snakeroot*, and *pennyroyal*, have been classed under this head.

Snakeroot and pennyroyal do not appear to be very efficacious. Mercury and its preparations, even when given in large doses, so as to cause profuse salivation, appear to be attended with little risk. But *savin* has some pretensions to be considered a dangerous drug: for, in common with other irritant poisons, it has undoubtedly occasioned abortion in more than one instance, though it has failed in others, and in others, again, has killed both mother and child.

Closely allied to the so-called *emmenagogues* is the *secale cornutum*, or ergot of rye, which possesses the remarkable property of exciting the muscular fibres of the uterus to contract, and is in frequent use for that purpose. Concerning the efficacy of this

* 'Med. Observations and Inquiries,' vol. iii. p. 249.

remedy, much difference of opinion exists. Some authors have supposed that the power of the ergot is limited to the period of delivery, and to the state of full expansion and development of the uterus. But this opinion is refuted by cases in which it produced abortion at an earlier period of gestation, and experiments on animals have shown that it may be effectual at any period. On the other hand, several cases are recorded by Drs. Condie and Beck, in which repeated large doses of ergot failed to produce abortion.

The root of a plant called the *Actæa racemosa* has the reputation of being nearly as active as the ergot.

Digitalis has been classed among abortives on the strength of a case related by Dr. Campbell. The drug was given for dropsy; the child was still-born, and the mother died soon after. Mr. W. H. Dickinson ('Med. Chir. Trans.,' vol. xxxiv. p. 1) has shown that digitalis in such doses as from ʒss. to ʒiss. of the infusion, and ♏xx. to ♏xl. of the tincture, has a specific action on the womb; and its power of producing abortion, though not proved, is to be inferred from the facts stated.

It results from these observations on the power of drugs, that there is no medicine that can be depended on to procure abortion in women not strongly predisposed; that, if given in doses short of those which risk the life of the mother, they would almost certainly fail; that, when they do succeed, they place her life in jeopardy, and often sacrifice it; and that, for every case in which the mother escapes, there is probably one at least in which mother and offspring both perish, and one in which the mother dies, the child remaining intact in the womb.

Local, or *Mechanical means*.—These consist either of *external violence*, or of *instruments introduced into the womb*.

External violence is a sufficient cause of abortion. But it would appear that unless it is such as to endanger the life of the mother, it is not likely to succeed.

In 1811 a man was executed at Stafford for the murder of his wife. She was pregnant, and he succeeded in inducing abortion by violently elbowing her in bed, rolling over her, &c.; but he also caused her death.* A female in the last month of her pregnancy was struck on the abdomen by her husband. An extensive detachment of the placenta caused the immediate death of the fœtus, and that of the mother fifty-one hours after.†

Severe injuries not directly inflicted on the abdomen often fail to occasion abortion. Thus, Madame La Chapelle tells us of a young midwife, who was pregnant and had a narrow pelvis; and,

* Smith's 'Forensic Medicine,' p. 305. † Campbell, op. cit. p. 131.

to procure abortion and avoid the Cæsarian section, threw herself from a height. She died from her wounds, but did not miscarry. Mauriceau also gives the case of a pregnant female seven months gone, who to escape from a fire slid down from the third storey, but losing her hold, fell on the stones and fractured her forearm; but there was no abortion.

The same remarks apply to the *introduction of instruments into the womb* by unskilful persons. In some instances abortion has been procured; in others, after considerable injury had been inflicted on the vagina and uterus, the child was born alive; and in all of them the mother's life has been endangered or sacrificed.

Sulphuric acid has been injected into the vagina with a view of producing abortion; and occasioned violent inflammation of the parts, and adhesion of the os tincæ, with the formation of a dense membrane over it. After attempting delivery by incisions into the neck of the womb, it was found necessary to perform the Cæsarian operation—and both mother and child died.*

A case which occurred in the practice of Dr. Wagner, of Berlin, illustrates so forcibly the difficulty of procuring abortion in women not predisposed, whether by medicines or by force, that it will form a fitting conclusion to this subject.

A young woman, seven months with child, had employed savin and other drugs to produce miscarriage. As these failed, her paramour bound a strong leathern strap (the thong of a skate) tightly round her body. This too availing nothing, he (by his own confession) knelt upon her with all his weight, and trampled on her while she lay on her back. "As this also failed, he took a sharp-pointed pair of scissors, and proceeded to perforate the uterus through the vagina. Much pain and hæmorrhage ensued, but did not last long. The woman's health did not suffer in the least; and pretty much about the regular time, a living child was brought into the world without any marks of external injury upon it."

Examination of the female.—We should be guided in this by the signs already laid down at p. 69; bearing in mind that they are less strongly developed in the early months, and that before two months little dependence can be placed on them.

If the female dies, we may be required to examine the body, and must be guided by the signs of delivery as at the full period, but less distinct as the period of utero-gestation is earlier.

The following is a summary of the chief points to be attended to in cases of *abortion*:—

* Report of M. Guerin to the Académie Nationale of Paris, cited in the 'Lancet,' vol. viii. p. 38.

1. The supposed product of conception must be submitted to minute and careful examination. If a fœtus has been expelled, its age must be determined by the rules already laid down.

2. The reputed mother, whether alive or dead, must then be examined;—if alive, we must ascertain, if possible, whether there was such a predisposition to abortion as to account for it without attributing great efficacy to the means employed. To determine whether or not such a predisposition exists, we must inquire into the general state of health of the mother before the abortion took place, and especially whether she has had previous abortions—and if so whether they occurred at or about the same period of gestation. If the female died from the means employed, we must use the same care in examining the uterus, and must observe the rules hereafter to be laid down for conducting post-mortem examinations.

Some questions of medical ethics mix themselves up with the question of abortion, as

Under what circumstances, and by what means, is it morally and legally proper to induce premature delivery? and what circumstances will justify the Cæsarian operation?

Such questions are easily answered. The medical man is clearly justified in resorting to any measure which promises to preserve the life of mother and child when both are threatened; and where one only can be preserved, the female herself may use her right of self-preservation, and choose whether her own life or that of her child shall fall a sacrifice to the means recommended.

INFANTICIDE.

There are no criminals who meet with so much sympathy as women guilty of Infanticide. This feeling, largely shared by members both of the medical and legal profession, is partly explained by the exceptional nature of the crime, and partly perhaps by the extreme harshness and cruelty of a former statute (21 Jac. I. cap. 27), which virtually visited the concealment of shame with the punishment of murder. It was under the influence of that injustice that Dr. William Hunter, in 1783, wrote his celebrated essay 'On the Uncertainty of the Signs of Murder in the Case of Bastard Children.' About a quarter of a century later (1803) an Act was passed decreeing that women accused of infanticide should be tried by the same rules of evidence as obtain in other trials for murder; but that if acquitted, they may be tried for concealment of the birth, and, if found guilty, punished by imprisonment for a term not exceeding two years.

The provisions of this statute were confirmed by an Act passed June, 1828 (9 Geo. IV. cap. 31), which also provides that it shall not be necessary to prove whether the child died before, at, or after its birth. The Consolidation Act (24 and 25 Vic. cap. 100) adopts and extends these provisions.*

Questions of infanticide are necessarily more complicated than those of homicide in general; for, before inquiring how a child has come by its death, it is necessary to show that it was born alive. The suspected mother may also have to be examined, in order to determine whether or not she has been recently delivered.

Two classes of questions, then, may be raised in cases of infanticide: the one relating to the child; the other to the mother.

Those relating to the child are the following:—

1. What is the degree of maturity of the child?
2. Was the child born alive?
3. If born alive, how long did it survive its birth?
4. How long has the child been dead?
5. What was the cause of death?

I. MATURITY OF THE CHILD.

This will be determined by a careful comparison of the length and weight of the child, the position of the centre of the body, the proportional development of its parts, the growth of the hair and nails, the state of the skin, the presence or absence of the membrana pupillaris: and, in the male, the descent or non-descent of the testicles, &c. (See *ante* p. 73).

II. WAS THE CHILD BORN ALIVE?

The legal meaning of the term *born alive*. To constitute live-birth, the child must be alive after the whole body has been

* § 60. *Concealing the birth of a child*, is to the following effect:—"If any woman shall be delivered of a child, every person who shall, by any secret disposition of the dead body of the said child, whether such child died before, at, or after its birth, endeavour to conceal the birth thereof, shall be guilty of a misdemeanour, and being convicted thereof shall be liable at the discretion of the Court, to be imprisoned for any term not exceeding two years, with or without hard labour: provided that if any person tried for the murder of any child shall be acquitted thereof, it shall be lawful for the jury, by whose verdict such person shall be acquitted, to find, in case it shall so appear in evidence, that the child had recently been born, and that such person did, by some secret disposition of the dead body of such child, endeavour to conceal the birth thereof, and thereupon the Court may pass such sentence as if such person had been convicted upon an indictment for the concealment of the birth."

In Scotland concealment of pregnancy is a statutory offence. By the 49th Geo. III. c. 14 it is enacted that "if any woman shall conceal her pregnancy during the whole period thereof, and shall not call for and make use of assistance in the birth, and if the child be found dead or amissing, she shall be imprisoned for a period not exceeding two years." It is common to prefer this charge of concealment instead of the graver one of child-murder.

brought into the world; and it must have an independent circulation; but this does not imply the severance of the umbilical cord.

In examining the body of a child with a view to determine whether it was born alive, the chief point to be attended to is the state of the lungs: for if we find in these organs signs of respiration, there is a probability in favour of live-birth; if not, there is an equally strong probability that the child was still-born. But as, in the absence of signs of respiration, proof may still be forthcoming that a child has or has not been born alive, the present inquiry will consist of two parts. 1. The evidence of live-birth, prior to, and independent of, respiration. 2. The evidence of live-birth subsequent to, and deduced from, respiration.

The evidence of live-birth prior to respiration is either negative or positive,—negative when we find signs of previous death within the womb, and positive when there are such injuries on the body of the child as must have been inflicted while the blood was still circulating, and so extensive and severe that they could not have resulted from accident, or have taken place *during* the birth.

Intra-uterine maceration.—A child that has died in the womb, and there undergone maceration, presents the following appearances:—All parts of the body are shrunken and flaccid, the chest and abdomen flattened, the ribs distinctly visible through the skin, the ilia prominent, the head so soft and yielding that it falls flat in whatever position it may be placed, and the periosteum readily separates from the bones. The cuticle is detached in patches, and easily separates from the true skin, and on the hands and feet is white, thick, and wrinkled, as if from the application of a poultice. The true skin is more or less extensively discoloured, the change beginning on the abdomen, which has a mottled appearance, blending a rose and ash colour. Elsewhere the skin assumes a brownish-red, without admixture of green; and the parts of generation have a deep-red colour, as have also, in a less degree, the head and face. The umbilical cord is straight and flaccid. The whole surface is covered with a soapy fluid, so that the body, when handled, slips from the grasp. The cellular membrane, when cut, is found filled with reddened serum, and in parts, especially in the scalp, with a substance aptly compared to gooseberry jelly. The cavities are filled with an abundant bloody serum, and the minute structure of the viscera, which are tinged throughout of a reddish-brown colour, is very distinct.

These appearances, which are more or less distinct, as the child

has lain a longer or shorter time dead in the womb, cannot be mistaken for those due to any other cause. They are quite different from the effects of putrefaction, whether in air or water, and the putrefactive odour is entirely wanting. But, of course they are not present when the death of the fœtus took place only a short time before its expulsion from the womb. The annexed engraving shows the appearance of the body of a fœtus in which intra-uterine maceration had proceeded so far as to cause extensive separation of the cuticle. The colour of the true skin was a deep rosy red on the body, a deeper tint on the head, and a still stronger colour on the parts of generation.

Fig. 15.

The single case in which, anterior to, and independent of respiration, we may state that a child was born alive, is, when we find marks of violence on the body so severe that they could not have originated during the birth, and attended with hæmorrhage so abundant that it could only have occurred while the blood was still circulating. Thus Devergie relates a case of an infant that had not breathed, yet was proved to have been murdered, by extensive wounds and marks of great violence on the head, with copious effusion of blood.* To justify a positive opinion, the loss of blood must be large; for a severe wound inflicted on a plethoric infant after the circulation had ceased, might be attended with considerable hæmorrhage.

* 'Annales d'Hygiène,' May, 1837.

There are two cases, then, in which, independent of, and anterior to, respiration, we may decide the question, "was the child born alive?" negatively, when we find the marks of intra-uterine maceration; affirmatively, when we discover injuries so extensive and severe, that they must have been inflicted after the birth, and while the blood was still circulating.

But the cases must needs be very rare in which evidence can be obtained, or will be needed, of live-birth before respiration; for very few children in whom the blood is still circulating are born without breathing, at least imperfectly.

In the great majority of cases, then, evidence of live-birth must be sought for in the lungs, proof of respiration being the first link in the chain of evidence that the child was born alive. We have first to show that the child had breathed, and then that the act of breathing took place after the birth; for it may have breathed during the birth and yet have perished before that complete delivery which constitutes live birth.

HAS THE CHILD BREATHED?

The best evidence of respiration is the change it produces in the external appearance of the lungs; and, were it not that inflation gives rise to the same change, mere inspection would supersede all other tests. As it is, it serves to establish the alternative of respiration or inflation when all other means fail.

Lungs which have neither breathed nor been inflated, are of a uniform firm texture throughout, and resemble in colour and consistence the adult liver. Their surface is marked by slight furrows, which obscurely denote the division of the lobules. In lungs that are full of blood, these are scarcely visible; but in lungs that contain little blood, they are more distinct, and are very strongly marked after intra-uterine maceration. The lungs are also sometimes found studded with small melanotic spots of various shapes.

The effect of respiration or inflation varies according to its degree. The smallest quantity of air developes some of the cells on the surface of the lungs, and these form the best proof of the admission of air in one or other of these ways. The right lung, and especially the edges and concave surface of its upper lobe, admit air most readily; and it is here that the first effects of inflation or respiration must be looked for.

The appearance of the air-cells thus developed is highly characteristic. If the lungs are fresh and full of blood, they take the form of brilliant vermilion spots; if the lungs contain less blood, or are examined some days after death, the spots are of a lighter

tint; and in children who have survived their birth some days they have very nearly the hue of the healthy adult lung.

The form and arrangement of these cells are not less characteristic than their colour: they are angular, are not perceptibly raised, and are obviously in the substance, though near the surface, of the lung. The grouping of the cells is generally irregular, but they are sometimes found in regular and symmetrical groups of four. Their ordinary appearance and grouping is shown in the annexed wood-cut, taken from a coloured drawing of lungs in which respiration had been imperfectly set up.*

Fig. 16.

The only appearances on the surface of the lungs with which these developed air-cells might possibly be confounded, are, 1, melanotic spots; 2, spots of blood; and 3, air-bubbles, the product of putrefaction. The first two appearances are at once distinguished by their characteristic colour, and the absence of anything resembling a developed texture. Both kinds of spot generally assume a round form.

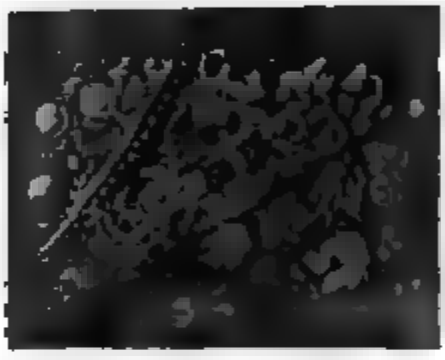
The appearances caused by putrefaction are quite as characteristic. The air collects on the surface, and between the lobes of the lungs, either in detached projecting globules, the size of peas, or in strings of small vesicles, like a fine mercurial injection beneath tissue-paper. It is evidently contained in the cellular membrane which connects the pleura with the surface of the lung, and its true situation is often pointed out by a small globule seated on a larger one. If these appearances were not sufficient to distinguish air, the product of putrefaction, from air in the air-cells, it would suffice to pass the finger over the surface of the lung. The air follows the movement of the finger, and a gentle pressure effaces the bubbles, and even breaks down the larger globules. No amount of pressure so applied will force the air out of the air-cells, or in any way alter their appearance.

Some authors, as will be presently more fully stated, have spoken of an emphysema of the fœtal lungs as giving rise to some difficulty in applying the hydrostatic test; but it will be shown that this so-called emphysema is merely an incipient process of putrefaction, causing the same appearances, and admitting of the same ready discrimination. The subjoined engraving (fig. 17) is as faithful a representation, on a somewhat enlarged scale, as it is possible to give, without colour, of the appearances just described. With the exception of the large air-bubbles, taken

* I have once seen the air-cells as a group of small globules, like millet seeds, arranged closely side by side, on the same level. (G.)

from another subject, they were all present on a limited space of the same lung. The air-cells are recognised by their peculiar shape and grouping; the rounded dark spots are melanotic, the fainter spots are effused blood; the string of small light round dots, and the large circular spots, are air-bubbles.

Fig. 17.



The contact of the air with the surface of the fresh fœtal lung gives rise to exactly the same change of colour as is seen in the developed air-cells; but this contact of air in no way alters their texture.

The appearance of the developed air-cells is, therefore, characteristic; it furnishes undeniable proof either of respiration or of inflation. It is the only lung-test to which no serious objection can be offered; and it is as delicate as it is simple; for it detects a quantity of air too small to affect the specific gravity either of the whole lung, or of the parts into which it has been introduced. I have repeatedly detected at a glance, in the superficial air-cells, a quantity of air insufficient to render the smallest fragment of lung buoyant; and I have never found these signs of respiration absent in any case in which a child was stated to have breathed, though for the shortest space of time. In one case in which the child was reported to have given only three gasps, the result was obvious, at a glance, in the bright vermilion-coloured groups of developed air-cells scattered over the surface of the right lung. (G.)

If respiration produced a different appearance in the air-cells from that caused by inflation, and we could infallibly distinguish the one from the other, there would be no need of any other lung-test.

Now, Devergie,* after stating, correctly enough, that a careful examination had enabled him to distinguish, *à priori*, and without any other research, lungs belonging to a still-born infant from those of an infant which had breathed; and also to determine whether the air had dilated all parts of the lungs, or merely certain portions, adds, that "in *many* cases he could determine whether the distension of the lungs with air was the effect of respiration or of insufflation." In respiration he states that there is a minute injection of capillary vessels on the surface of the air-cells, which does not take place in inflation. This distinc-

* 'Médecine Légale,' art. Infanticide.

tion may be well founded, but as it deals with very minute parts, and, according to the author's own statement, is to be relied on only in *many*, but not in *all* cases, it may be set down as unfit for medico-legal use. I have not myself observed such a difference between the effects of inflation and respiration as to pretend to be able in this way to distinguish the one from the other. (G.)

Developed air-cells, then, form the best, and only necessary proof, of the admission of air into the lungs; and they are to be found in every case of respiration or inflation, however limited in extent, or slight in degree.* The number of the cells is, moreover, a measure of the extent to which these processes have been carried. When respiration is complete, the lungs present the same spongy, crepitant character as in the adult, and differ from them only in having a more rosy hue.

Before proceeding to the other lung-tests, we must premise that respiration is not a sudden, but a gradual process; that it is rarely, perhaps never, completed in a few respirations; that it very often remains incomplete and partial after many hours, days, or even weeks; and that in some grown-up persons portions of lung are even believed to retain their fœtal state. In the great majority of cases of infanticide, therefore, we shall have to deal with lungs in which respiration has been very incompletely set up. Hence the importance of a sign which stands us in stead where, as will be presently shown, every other test may fail.

But the admission of air into the cells of the lungs is not the only effect of respiration. As a general rule it is attended by an increased afflux of blood, adding to the weight of the lungs, both when taken by themselves, and when compared with the weight of the body to which they belong. This increase of weight, absolute and relative, has been made the basis of two lung-tests.

Absolute Weight of the Lungs.—This test of respiration rests on the assumption that the arteries and veins of lungs which have not respired, are empty, and in a state of collapse, while after respiration they become more or less filled with blood. That this statement of Foderé, since corrected by Orfila and Devergie, is most erroneous, I have had many opportunities of proving; for I have found lungs which had breathed almost destitute of blood; and others that had never admitted air, or presented only a few groups of developed cells, gorged with blood in every part. (G.)

The early estimates of weight were in accordance with these mistaken assumptions. The lungs of mature children before

* It is strange that this simple sign of respiration should have been so often overlooked. Cruveilhier, in his 'Morbid Anatomy,' depicts the bright vermilion air-cells as a disease of the fœtal lungs.

respiration were stated to weigh one ounce, or 480 grains; after respiration two ounces, or 960 grains. How remote these estimates were from the truth, the following averages, founded on upwards of 400 observations on mature children, will show:—Still-born, 874 grains; children who had survived their birth one month or less, 1072 grains. The observed weight, therefore, in still-born children is nearly double the rude estimate of authors; and the increase after respiration, instead of being equal to the original weight, is less than one-fourth. These averages differ too little to admit of application in a court of law; the extreme figures are still more conclusive, as the comparison made in the following table will show.*

Before Respiration.	After Respiration.	Before Respiration.	After Respiration.
510	510	694	—
520	—	703	—
550	546	713	726
—	562	744	746
586	590	—	774
630 (two)	—	—	861
632	—	—	920
640	—	1054	1000
647	—	—	1173
658	—	—	1189
666	—	—	1203
683	675	1480	—
687	—	1950†	—

	Before.	After.
Maximum . .	1950	1203
Minimum . .	510	510
Mean	769	820

From this table it appears that out of 34 cases, there is not one in which we could have stated, by means of this test alone, that respiration had, or had not, taken place; while, in two instances, the great weight of the lungs would have led us to infer respiration in still-born infants.

As in most cases of alleged infanticide the lungs, if the child has breathed at all, are found to contain but little air, it is important to determine the effect of imperfect respiration in increasing their weight. The following are the average figures

* For the particulars of these observations, which are all taken from English sources, see 'Lancet,' Oct. 1, 1842. The case marked† has been subsequently added. It is given on the authority of Dr. Taylor.

from a large number of facts:—Still-born, 874 grains; imperfect respiration, 988; perfect respiration, 1195. So that the effect of imperfect respiration is to increase the weight of the lungs by about 100 grains, or one-eighth of their original weight.

Different durations of respiration affect the weight of the lungs as follows:—Still-born, 874 grains; less than one hour, 918; twelve hours, 853; one day, 1000; one month and less, 1072 grains. Hence one hour's respiration adds less than 50 grains to the weight of the lungs, which is increased by only 126 grains when respiration has lasted one day.

If additional evidence were required of the uselessness of this test, it might be found in a comparison of the weight of the lungs in two children born alive with the same weight of body. In the one the lungs weighed 494, in the other 1544 grains, or more than three-fold.

The difference, then, between the absolute weight of the lungs before and after respiration, and especially after imperfect respiration, or respiration of short continuance, is much too slight to be used as a test; and the inference drawn from a comparison of average weights is fully confirmed by that of the extremes.

The absolute weight of the lungs has been recommended as a means of distinguishing respiration from inflation. But this it cannot do; for it is obvious that inflated lungs are, as to the blood they contain, in the exact condition of fœtal lungs.

Ratio of Lungs to Body.—Ploucquet's Test.—Before examining this test, we must premise that still-born infants are heavier by about one-third than those born alive; that males are heavier than females; that the ratio of the lungs to the body decreases as the weight of the body increases; and that the weight of the lungs is even more variable than that of the body.

This test is a good example of the futility of conclusions drawn from a small number of facts. Ploucquet, making use of three facts, only two of which were strictly comparable, happened to obtain the proportion before respiration, of 1 to 70; after respiration, of 1 to 35. But that these figures are very far removed from the true proportions, the following averages, drawn from more than 400 observations on mature children, will show—Still-born 1:57, instead of 1:70; children surviving one month or less 1:38 instead of 1:35. The extremes, which, as before observed, are the values required for practical purposes, are shown in the following table:—

Before Respiration.	After Respiration.	Before Respiration.	After Respiration.
1:91	—	1:54	1:55
1:82	—	1:51 (two)	1:52
1:74	—	1:49	1:49
1:71 (two)	—	—	1:48
1:70	—	—	1:46
1:67	1:65	1:45	1:45
1:61	1:61	—	1:44 (two)
1:60	—	—	1:41
1:59	1:59	—	1:39
1:57 (three)	1:56	1:21	

	Before.	After.
Maximum . .	1:21	1:39
Minimum . . .	1:91	1:65
Mean	1:60	1:50

The results of this table differ somewhat from those obtained in the case of the absolute weight of the lungs; for in 7 cases out of 83 there is a probability, derived from the low ratio, that respiration had not taken place; but, on the other hand, there is one case in which, relying on the high ratio of 1:21, we should have mistaken a still-born child for one that had breathed.

The following are the mean proportions after different durations of respirations:—Still-born, 1:57; less than one hour, 1·51; 12 hours, 1:53; 1 day, 1:48; 1 month, or less, 1:38.

The difference between these several proportions is certainly much too small to justify the use of the test in cases of imperfect respiration, in which alone it would be required.

If further proof were needed of the futility of this test, it might be found by a simple comparison. The weight of the body being in each of two children born alive 32,436 grains, the lungs bore to the body in the one the proportion of 1 to 21, in the other of 1 to 66; the first ratio being more than three times as great as the second.

The same remarks, then, apply to both these tests. Simple inspection would render them superfluous even if they were useful, and they cannot serve to distinguish inflation from respiration: therefore both tests should be allowed to fall into disuse as alike unsafe and unnecessary.

The Hydrostatic Test.—This test is very interesting from the controversies to which it has given rise, the important purpose to which it was applied, and the high value formerly assigned to it. That it may be understood, it must be premised, that though,

when first proposed, it was erroneously considered a test of live or still-birth, it is merely a test of respiration: also that the test has undergone several modifications since it was first proposed towards the end of the seventeenth century. Originally, and till a comparatively recent period, it consisted in placing the lungs, with or without the heart attached, in a vessel of water of the temperature of about 60°. This rough test was first modified to the extent of dividing the lungs into several pieces, and experimenting with them as with the entire lungs. The test, as now performed, consists in first immersing these pieces of the lungs in water, and then applying to them the subsidiary test of pressure. It will be presently seen that the objections to the hydrostatic test apply to it chiefly as originally performed; and that this addition of pressure removes at least one objection, though it leaves others in full force, and opens an important inquiry as to the distinction between the effects of respiration and inflation.

It will be convenient to consider first the value of the test as originally performed, including the addition subsequently made of dividing the lungs into several portions, but without submitting them to pressure; and with the distinct understanding that it can in no case be a test of live-birth, but only of respiration. A supporter of the test thus applied would assert on its behalf, that, if the lungs, whether entire or divided into portions, when placed in a vessel of water, sink to the bottom, respiration has not taken place.

To this assertion there are two objections. 1. That respiration may have taken place, and yet both the entire lungs, and the several parts into which they have been divided, may sink in consequence of disease. 2. That respiration may have taken place, but to so limited an extent, or in so imperfect a manner, that the lungs and every part of them, though perfectly healthy, and containing only the ordinary quantity of blood, may nevertheless sink.

In examining the first objection, it must be borne in mind that disease may exist before respiration or supervene after it. If before respiration, and the disease does not affect every part of the lungs, the healthy portions would receive air and float, if the quantity of air admitted into them were sufficient. If, on the other hand, the disease supervene after respiration, it is unlikely (though a case of double pneumonia fatal the eighth day, in which both lungs "sank completely even to their smallest particles," is recorded by Casper) that it would consolidate the whole of both lungs. Some portions, therefore, would be found to float. So that, whether the disease occurred before or after respiration, the

cases must be extremely rare in which it would constitute a valid objection.

In the case of partial disease of the lungs, the first objection merges in the second; for if lungs healthy in all their parts may respire without becoming buoyant, it follows that the healthy portions of diseased lungs may receive air in quantities equally inadequate to cause them to float.

That the second objection, viz.:—That respiration may have taken place, but to so limited an extent, or so imperfectly, that the lungs and every part of them, though perfectly healthy, and containing only the usual quantity of blood, may sink, is valid, a single case will suffice to prove. In a female twin, weighing little short of five pounds and probably nearly mature, "The substance of the lungs was healthy, of a deep Modena-red colour, with here and there patches of a somewhat lighter hue." There was no crepitation under the knife, nor any congestion.* Both lungs, when placed in water, sank with equal rapidity; as did every one of the fifteen pieces into which each lung was divided: and on compression below the surface no air-bubbles escaped. This child had survived its birth twenty-four hours, and this case is by no means unique; for similar ones have been reported by Bernt, Remer, Orfila, Daniel, Schenk, and Osiander.

Billard, meeting with some of these cases, fell into the strange error of supposing, that children may survive their birth for hours, and even days, without breathing.† I have myself repeatedly examined lungs in which respiration had been very imperfectly set up in several parts of one or both, and yet only one or two of these parts floated. But I have not met with any instance in which every portion of both lungs sank. (G.)

The two objections, then, to the statement that the sinking of the lungs, whether entire or divided, is a proof that respiration has not taken place, are both valid as applied to the hydrostatic test in its original form; and they of course apply equally to lungs healthy in all their parts, and to those which have only portions of their structure free from disease.

Let us now suppose that the lungs, or one or more of the parts into which they have been divided, float; and that this buoyancy of the whole lung, or of its parts, is alleged as proof that respiration has taken place. This assertion would be met by three distinct objections. The buoyancy may be due, not to respiration, but 1. to Emphysema; 2. to Putrefaction; or 3. to Inflation.

* Dr. Taylor in 'Guy's Hospital Reports,' No. v. case 4.
† 'Maladies des Enfans,' title Viabilité.

1. The first objection, that the lungs may float in consequence of emphysema, is easily disposed of. The term emphysema, in its usual acceptation, means an enlargement or rupture of the air-cells caused by air introduced in respiration, or by inflation. Now, air introduced in respiration will so expand the air-cell as to furnish, independent of the emphysema itself, distinct proof that the child has breathed; and, if the emphysema were caused by inflation, the first objection would become identical with the third. But the emphysema urged as an objection to the hydrostatic test is quite a different thing, supposed to be due to air generated by some peculiar action of the lung tissues. This was Dr. Cummin's* opinion. He thought that infants might suffer violence in the birth through the labour being tedious and the mother malformed; that the sides of the chest might be so pressed against the substance of the lungs as to injure them; that so "they became inflamed and puffy, containing air in large vesicles on their surface, and this is what some authors call emphysema." Lécieux also, in extracting an infant by the feet, often found that a part of the lungs floated, though the child died in the course of the delivery, and had certainly not breathed. He could not attribute this buoyancy to putrefaction, for the infant was fresh, and was examined soon after extraction; but he thought that as we sometimes see a wound or bruise, especially on the head, accompanied by an emphysematous swelling, the lungs, during the extraction of the fœtus, might suffer a sort of contusion; that blood might be effused into their tissue, might lead to the formation of some bubbles of air, and to the consequent buoyancy of a part of the lungs.†

The true explanation of the formation of air in the tissue of lungs free from putrefaction is to be found in a simple fact that came under my notice in the winter of 1840. I examined the body of a mature still-born fœtus, within forty-eight hours of its extraction by instruments. There was not the slightest trace of putrefaction in the body or in the lungs; no change of colour, no softening of the tissues, no putrefactive odour, and, with the exception of a vesicle the size of a pea on the surface of one of the lungs, no formation of gas. The lungs, which were gorged with blood, were extracted, put into a gallipot, and carried in the pocket about two hours; at the end of which time their whole surface was found studded with vesicles, some as large as a pea, others smaller than a pin's head.

In that short space of time a very large quantity of gas was

* 'The Proofs of Infanticide Considered,' by William Cummin, M.D., p. 61.
† Lécieux: 'Considérations Médico-légales sur l'Infanticide.'

developed, though the lungs had certainly sustained no injury in the birth, and no single sign of putrefaction could be detected.*

This incipient putrefaction, for it is nothing less, is not limited to the lungs, but occurs in effusions of blood on the brain (of which I have seen two examples) and in parts of the body containing an unusual quantity of blood. The lungs in which it occurs are usually congested, or the seat of the pulmonary apoplexy which is so apt to occur in tedious labours, or in infants extracted by instruments.

This so-called emphysema being, therefore, nothing more than an incipient process of putrefaction, the first objection to the floating of the lungs as proof of respiration merges in the second; and instead of three objections we have two: 1. The formation of air in the cellular tissue in consequence of incipient or advanced putrefaction: and 2. Inflation.

1. *Putrefaction.*—The possibility of the lungs floating from putrefaction was formerly questioned, but without reason. The real origin of the doubt is shown by some experiments which I made in the winter of 1839.

The lungs of some still-born children, when placed in water, as soon as putrefaction set in, rose gradually to the surface, remained there several days and then slowly sank to the bottom. In other lungs, large air-vesicles were formed on the surface, but not in sufficient number to render them buoyant; in others, again, though the lungs gave out a strong putrefactive odour, there were no air-vesicles, and no tendency to rise to the surface, nor did they ever float either in the water in which they had stood, or in fresh water.

There is, therefore, no doubt that gases developed in the various stages of putrefaction may cause lungs that have not breathed to float; and this objection to the hydrostatic test, as originally performed, is accordingly valid.

2. *Inflation.*—The objection that the lungs may be rendered buoyant by inflation, is also valid, as the possibility of so inflating the lungs as to cause them to float is universally admitted.

* On referring to Casper's Handbook (vol. iii. p. 68) it will be seen that he only wanted such a fact as this to complete his exposure of the weakness of the grounds on which this objection of emphysema has been made to rest. His criticisms certainly warrant the statement "that not one single well-observed and incontestible case of emphysema developing itself spontaneously within the lungs of a fœtus, born without artificial assistance, is known, and it is not, therefore, permissible in forensic practice, to attribute the buoyancy of the lungs of new-born children, brought forth in secrecy and without artificial assistance, to this cause." The words "without artificial assistance," introduced to meet a case by Hecker, to which Casper attaches undue importance, would have been rendered unnecessary by a knowledge of the *experimentum crucis* described above, and now upwards of 30 years old.

It follows, then, that to the Hydrostatic Test, as originally applied, and used merely as a test of respiration, there are four valid objections; two to the sinking of the lungs as a sign that respiration has not taken place, and two to the floating as a proof that it has: to the sinking as a proof of non-respiration, disease, and imperfect respiration; to the floating as a proof of respiration, putrefaction (in its several degrees and stages) and inflation.

Such was the hydrostatic test, up to the time of the introduction of pressure as an auxiliary.

The Hydrostatic Test modified by Pressure.—The mode of applying pressure is not material, provided it be not carried to the extent of destroying the lung texture. Air, the product of putrefaction, is readily expelled by the pressure of the finger and thumb under water; but if stronger pressure be required, the fragment of lung may be placed in a clean cloth, and the cloth twisted opposite ways. In experiments presently to be described, the fragments of lung were submitted to still stronger pressure by treading the cloth under foot.

A supporter of the hydrostatic test, in this its modern signification, would assert, on its behalf, that if the lungs, both entire and divided, when placed in water, sink, both before and after being submitted to pressure, that respiration has not taken place. The objections to this assertion are the same that apply to the earlier test, viz., disease and imperfect respiration; with this difference, however, that portions of lung containing a large quantity of blood and too little air to render them buoyant, might possibly float after a portion of the blood had been forced out, and its texture flattened. Hence the sinking of the lungs after pressure, would afford a stronger reason for supposing that respiration has not taken place.

But should the several portions of the lungs float, both before and after pressure; and this buoyancy of the lung be taken as a proof of respiration, do the two objections urged with success against the earlier test, viz., putrefaction and inflation, hold good against this modern test also?

The objection on the score of putrefaction falls at once to the ground; for the mere pressure of the fingers expels the air generated by putrefaction, and causes the lungs to sink. There remains, therefore, the single objection, that inflation may cause the lungs to float.

That air so introduced into the lungs will render them buoyant, there can be no doubt; but whether pressure will distinguish the buoyancy due to respiration from that due to inflation is a question that demands very careful consideration.

The addition of pressure to the old hydrostatic test was suggested by Béclard, and introduced into practice in this country by Dr. Taylor,* and Mr. Jennings,† both of whom employed it as a diagnostic mark. The former concludes from repeated experiments, "that air, introduced by artificial inflation, may, under all circumstances, be expelled by compression, if the experiment be properly performed, and the pressure continued a sufficient length of time."‡ Mr. Jennings states, that "air introduced into the lungs, by artificial inflation, may be expelled by pressure, so that the lungs will sink in water," and on the other hand, that "after respiration, the air cannot be expelled from the lungs without completely breaking down the structure of every part of the organ. Any part, however small, not thus broken down, will continue to float."

This statement of Mr. Jennings respecting respired air is wanting in exactness, and is corrected by Dr. Taylor, on the authority of Case III. in the Essay just cited.§ This case proves "that air, from respiration," (imperfect respiration,) "may, by very moderate pressure, be forced out from divided portions of the organs;" while Case II. shows "that there are no satisfactory means of distinguishing artificial inflation from feeble respiration." Schmitt also reports a case in which only the middle lobe of the right lung of an infant that had lived twenty-four hours, and in which inflation had not been practised, floated, and that imperfectly, but sank again when forcibly compressed.‖

This test, then, does not distinguish imperfect respiration from imperfect inflation. On the other hand, my experiments made in the year 1841 prove that lungs completely distended by inflation cannot be made to sink by pressure short of that which destroys their texture; and that lungs so distended with air differ from those that have breathed completely only by requiring somewhat more pressure to make them sink.

I subjoin an account of one of these experiments from notes taken at the time:—

"I took the lungs of a child two months old who had died of marasmus, and the lungs of a fœtus, still-born, at eight months. I inflated the fœtal lungs completely, and in doing so ruptured the air-cells, and produced emphysema over the entire surface, so that when I ceased to inflate them, the lungs rapidly collapsed.

* 'London Med. and Phys. Journal,' Nov. 1832, and Jan. and May, 1833.
† 'Trans. of Prov. Med. and Surg. Association for 1833.'
‡ 'Guy's Hospital Reports,' No. v.
§ The child survived six hours, and breathed very imperfectly.
‖ Schmitt, 'Neue Versuche,' &c., 93rd observation, p. 217.

I then took one lobe from the lung of either body, and, placing them together in a cloth, submitted them, by means of an assistant, to strong pressure. Both portions still retained their buoyancy. I next stood on the cloth, and repeatedly stamped on it, but still both floated, though their structure was almost destroyed. I then took a portion from the lungs of both children, distinguishing the lung which had breathed by the darker colour of its central portion, placed them both together in the same cloth, and proceeded as before. After applying pressure by twisting the cloth strongly, both pieces continued to float; they retained their buoyancy even after they were trodden on, and it was not till they were pounded with the heel, and their structure thoroughly broken up, that the inflated portion sank: the portion of the lungs which had breathed still floated, though imperfectly. On pounding this portion of lung a second time, this likewise sank. A second and a third experiment led to the same result, the inflated portion of lung sinking after a *less* degree of pressure than the portion which had breathed, but the structure being in both portions broken up before their buoyancy was destroyed." Another series of experiments was attended with the some result. (G.)

If, in these experiments, pressure, short of that required to break down the structure of the lung, had caused the inflated portions to sink, while the portions that had breathed could not be made to sink till their structure was destroyed, we could understand how *pressure* might become a means of diagnosis; but as the only difference is the degree in which the structure is broken up, and as, in any given case, we shall have to examine a portion of lung separately, and not side by side with one which we can take as a standard of comparison, it is obvious that this test is not applicable to medico-legal purposes.

It has been objected that these experiments, having been made on lungs inflated out of the body, do not admit of application to the case of lungs inflated within the body. This objection, of which it is difficult to see the validity, has happily been obviated by experiments upon lungs successfully inflated within the body. Two such cases, of which one was reported in the 'Medical Times,' Nov. 30, 1844, were communicated to me by Dr. Henry Browne, of Manchester, and two similar cases by Dr. F. J. Hensley, were published in the 'Medical Times,' Feb. 8, 1845. All these children were still-born, and the lungs were extensively inflated; but they could not be made to sink by pressure till their structure was broken up.* (G.)

* I am happy to be able to confirm this statement made more than a quarter

The only objections, then, to the hydrostatic test, coupled with such pressure as may suffice to dispel the products of putrefaction, are three:—1. The lungs may sink, and yet the child have breathed, inasmuch as respiration may have been too imperfect to render any part of them buoyant. 2. The lungs may sink, though respiration have taken place, in consequence of disease. 3. The lungs may float, and yet the child not have breathed, in consequence of inflation.

The following additional tests of respiration have been proposed:

Changes in Size and Shape of Chest.—The chest before respiration is stated to be small, narrow, and flattened; after respiration to be larger, and rounder. This test is not wanted in cases of complete respiration, while in imperfect respiration the presumed changes do not occur. It is needless in the one case and useless in the other.

Change in Position of Diaphragm.—The diaphragm, before respiration, is stated to be arched and to rise high in the chest; after respiration, to be flattened and depressed. This sign is open to the same objection as the foregoing.

Increased Volume of the Lungs.—The lungs are stated to be more bulky after respiration; this increased size being due partly to afflux of blood, but mainly to admission of air. This test is condemned by what has been already said of the static lung-tests. It also is needless when respiration is perfect or extensive, and useless when imperfect.

Altered Position of the Lungs.—Before respiration the lungs lie far back in the chest, leaving the thymus and pericardium uncovered, and presenting sharp edges; after respiration they project forwards, seem to fill the chest, nearly cover the thymus and pericardium, and have rounded edges. This is a description of fœtal lungs and of those that have fully respired: it is inapplicable to cases of imperfect respiration; for, in all these points fœtal lungs closely resemble those that have breathed imperfectly.

Altered Consistence of the Lungs.—Before respiration the lungs

of a century ago by the high authority of Casper. He says: "It is quite incorrect to suppose, as has been done, that the air can be easily *forced by compression* out of lungs artificially inflated, but not out of those which have respired, or, at least, that it is more easy to do so in the former case than in the latter. Both of these ideas are perfectly erroneous, as I have been taught by innumerable experiments, renewed every session in the course of my lectures. The air contained in the pulmonary cells, in whichever of these modes it has been introduced, can never again be expelled, even by the employment of the utmost violence, as by standing with the weight of the whole body upon a piece of lung, &c.; and the portion of lung thus forcibly compressed, floats almost as well after its compression as before it."—Handbook, vol. iii. p. 67.

are dense as liver; after respiration, spongy and crepitous. When they are spongy and crepitous, they have, of course, received air; but that air may have been either inflated or breathed. In imperfect respiration, the change in the lungs does not extend beyond the limits of the developed air-cells.

Weight of Liver compared with Weight of Body.—After respiration part of the blood which had circulated through the liver is diverted to the lungs. The liver, therefore, loses weight. Bernt, of Vienna, availed himself of this fact to encumber the subject of infanticide with another useless test; and Orfila took the needless pains to submit it to experiment. All the objections already advanced against the static lung-tests, and all that might be urged against any test whatever, apply to this.

To all the foregoing tests, then, there is one simple objection,—when respiration is complete they are needless, and when imperfect, useless; and they do not distinguish inflation from respiration, which is the only information not obtained by the first glance at the surface of the lungs.

The refinements of balances and graduated jars, with which some German authors have encumbered the hydrostatic test, may be safely consigned to oblivion.

A careful examination of the lungs themselves is the best, and only necessary means of determining whether or not they have received air through the air-passages. If the air-cells are developed, it can only be by respiration or inflation, and the number of cells so developed is the best measure of the extent to which those processes have been carried. The eye will detect these signs of the admission of air into the lungs where the quantity is too small to render any portion of their texture buoyant.

The practical directions for determining the question of respiration are, therefore, very simple. Proceed at once to extract the lungs, taking care not to injure them or the surrounding organs: examine them closely, and if they have throughout the colour and texture of the adult liver, respiration has not taken place; but if the surface is mottled with bright vermilion or rose-coloured spots, and these spots contain developed air-cells, then respiration or inflation has taken place.

It appears, then, that the only difficulty we encounter in ascertaining whether a new-born child has, or has not, breathed, arises out of the resemblance of the effects of inflation to those of respiration. This difficulty cannot be overcome by any lung-test, but it may be materially lessened by some very obvious considerations.

It is now generally admitted that the lungs of an infant may

be inflated through the mouth, without the aid of any instrument. All that is needed is to secure the nostrils, to force the windpipe back on the gullet, and to imitate the movements of respiration by alternately compressing and releasing the chest. Four instances of such successful inflation are referred to at p. 103 of this work. Schmitt succeeded more than once* in completely inflating the lungs in this way; in two so perfectly, "that not even a single point was to be found in either lung into which the air had not penetrated."† Such complete inflation is not readily effected even out of the body; for I have repeatedly removed the lungs, and inflated them by the blow-pipe, and in no case have I been able to expand their entire texture without rupturing some of the superficial air-cells.‡ (G.) It is not easy, therefore, even for an instructed and skilful person, to effect a complete expansion of the lungs; and it may be safely affirmed that such complete inflation could not be practised by an unskilful one. If, then, it were urged on a trial for infanticide, that the mother had tried to save the life of her child by inflating its lungs (for the supposition that this might be done maliciously to criminate the mother is simply absurd), and it appeared in evidence that the lungs were completely expanded, the objection must fall to the ground. But even if the lungs were found very imperfectly distended, it would admit of grave doubt whether even this could be effected by an uninstructed and unpractised female recently delivered.

But to make the plea of inflation by the mother at all feasible, she must have shown her anxiety to preserve the life of her offspring at least by making some preparations for her delivery, and preparing clothes for her child. In the great majority of cases of alleged infanticide, no such preparations have been made; and the plea of inflation would be still less tenable in that large class of cases in which the body of the child bears marks of violence.

Many attempts have been made to distinguish inflation from respiration. Metzger gives no less than four diagnostic marks, and states that inflation is distinguished by incomplete distension of the lungs, by flatness of the chest, by absence of crepitation when the lungs are incised, but chiefly by their bloodless state, such state not being accounted for by previous hæmorrhage. All these distinctions are unfounded; for imperfect respiration also

* Op. cit. Experiments lxxx. and xcviii., also x. xliii. and xlix.

† Elsässer, as quoted by Casper, seems to have been far from successful in his attempts to inflate the lungs of the dead infant without opening chest or abdomen.

‡ Page 102.

produces incomplete distension of the lungs, with flatness of chest, and absence of crepitation; and these may coincide with a bloodless state of the lungs. The static lung-tests have also been used as means of diagnosis; but as these tests do not distinguish respiration from non-respiration, and inflated lungs are, as far as concerns the blood they contain, in the state of lungs which have not breathed, it follows that the static lung-tests cannot distinguish respiration from inflation.

There is fortunately one available distinction on which little stress has been laid. In all unskilful attempts to inflate the lungs through the mouth, air is introduced in considerable quantity into the stomach. Its absence, therefore, from the stomach would go far to prove that inflation had not been practised.*

If, now, by careful inspection of the lungs, we have convinced ourselves that either respiration has taken place or inflation been practised; and further, that the body shows marks of violence, that the stomach does not contain air, and that the circumstantial evidence, strengthened by the general considerations respecting the difficulty of inflating the lungs, render the plea of inflation untenable, and leave no alternative but that the infant had breathed, a further inquiry is still needed before we can assert that it was *born alive*, in the sense the law attaches to that term. The question still to be answered is:—Did the infant breathe before, during, or after birth?

Respiration may take place before complete delivery, *a.* in the womb; *b.* in the passages; and *c.* after the delivery of the head.

a. Respiration may take place in the womb in cases of face-presentation; but this is a rare event, occurring only once in 280 deliveries. In this position, too, respiration would be extremely imperfect, so that any considerable expansion of the lungs would at once negative the supposition of the child having breathed within the womb, and perished before complete delivery.†

b. Respiration may also occur during the passage through the vagina; and especially if the hand is introduced to facilitate tedious labour, or change the position of the child. It must also be admitted to be possible in the absence of manual assistance, when the parts of the mother are capacious. In this class of cases, too, it is probable that respiration would be very imper-

* Casper points out as signs of inflation, crepitation on incision without escape of blood-froth, rupture of cells, a bright cinnabar red colour without marbling, and (perhaps) air in the stomach and intestines. Vol. iii. p. 68.

† With regard to this "vagitus uterinus"—this respiration in the womb, as a fact of practical value in cases of infanticide, Casper expresses a very justifiable scepticism. Vol. iii. p. 40.

fect, so that any considerable distension of the lungs would negative the supposition of respiration having occurred only in the vagina.

c. Respiration after delivery of the head, and before complete separation of the body from the mother, is a common event. In such a case there is not likely to be any serious impediment to complete delivery. Schmitt relates no less than nine cases of this kind which occurred in his own practice, and in all of them the child was born alive. On the other hand, a few cases are recorded in which children, having breathed in this situation, perished before the completion of the labour; and the same result may happen to children breathing in the womb or in the passages.

The possibility of respiration before the complete separation of the child from the mother is thus placed beyond a doubt; and it must be evident that the mere inspection of the lungs would not enable us to assert positively that respiration took place before, during, or after the birth. But if the lungs are found fully or even largely distended with air, we should be justified in assuming that respiration had not taken place only in these situations, but that the child was born alive.

But we may succeed in obtaining better evidence of live-birth than the state of the lungs can afford, by a careful examination of other parts of the body;—of the stomach, intestines, and bladder; of the organs of circulation, umbilical cord, and skin.

The changes in the organs of circulation, umbilical cord, and skin, are both proofs of live-birth, and means of determining how long a child has survived. These points will, therefore, be reserved till the indications to be drawn from the state of the internal viscera have been considered.

The *stomach* may contain milk or farinaceous food, proving that the child was born alive, and had lived long enough to be fed. Milk is readily identified by its physical characters, by the use of the microscope (see figs. 9 & 10, p. 70), and by Trommer's test, as used for detecting the presence of sugar in urine.* Farinaceous food may be identified by the starch it contains, which has characteristic appearances under the microscope, and strikes with iodine-water a blue colour; and by Trommer's test, if the food has been sweetened. The presence of blood in the

* Trommer's test. Add to the liquid to be examined a few drops of a weak solution of sulphate of copper, and caustic potass in excess, and apply the spirit-lamp. The liquid assumes a deep violet tint, and on being further heated deposits red sub-oxide of copper. This test gives characteristic results with the whey and curd of milk, as well as with liquids containing sugar.

stomach also affords a probability of live-birth, for it is more likely to have been swallowed than to have been poured into the stomach as the result of disease.

The large *intestines*, in mature still-born children, are filled with meconium; and though this may be partially expelled during labour, a considerable quantity of it remains in all cases of still-birth. Its complete expulsion, therefore, would furnish a strong probability that a child had survived its birth. But, on the other hand, the presence of a considerable quantity in the intestines must not be taken to prove that the child was not born alive, as its expulsion is sometimes delayed for some hours or days.*

The *bladder* is commonly emptied of its contents soon after birth; hence, if found empty, it has been assumed that the child was born alive; if full, that it was still-born. But this sign is most fallacious, for the bladder may certainly be emptied of its contents during labour, as it may be replenished should the child survive its birth some time. The statement of Casper that he has "unnumbered times" found a *full* bladder and an *empty* rectum, or the reverse, deprives these signs, taken together, of any value they might be supposed to possess.

The point of ossification in the lower epiphysis of the femur, spoken of in the note to p. 75 as a test of age, may be admitted among the signs of survivorship. But it must have a very limited application.

III. HOW LONG DID THE CHILD SURVIVE ITS BIRTH?

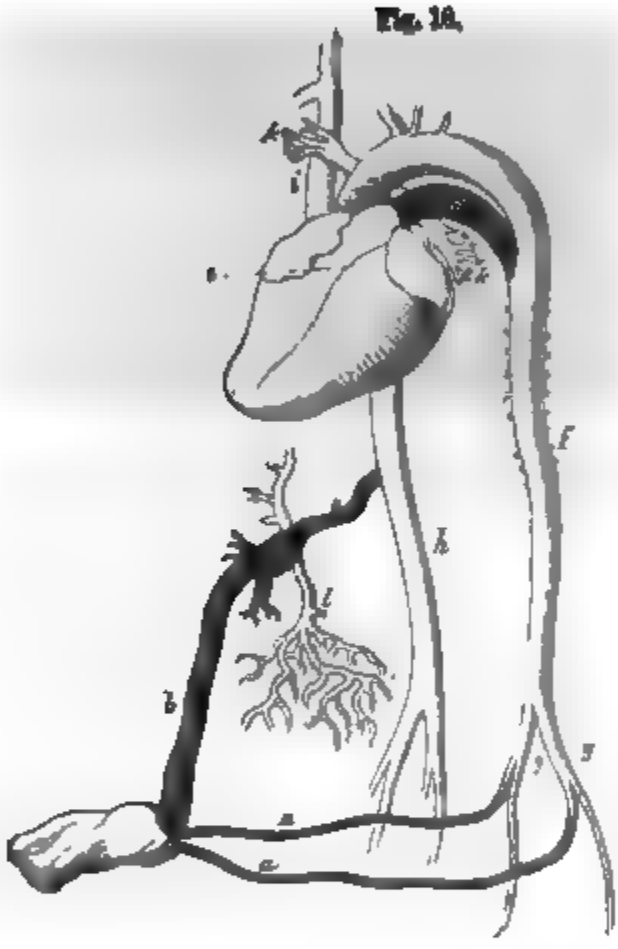
Our means of answering this question are less precise than could be desired. The extent to which respiration has taken place cannot be depended upon; and recent observations have tended greatly to impair the value of at least one of the three signs just referred to, namely—*a*. Changes in the organs of circulation; *b*. The state of the umbilical cord; and *c*. The state of the skin.

* A new test of live-birth has recently been suggested by Breslau, founded on the state of the stomach and intestines as regards their gaseous contents. He says that the intestinal canal of still-born children contains no gas, and that the occurrence of gas in the canal is independent of the presence of food, but due to the act of respiration. It shows itself first in the stomach, possibly from the swallowing of air during the inspiratory efforts, and gradually extends along the intestinal canal. So that in proportion to the duration and completeness of the respiration, the canal will be found distended with gas. Leman,† who has put this test to the proof in several cases, thinks that the fact of the intestinal canal of a fresh infant being found distended with air may be held to favour the idea of live-birth: but that when the body has undergone putrefaction, it is not to be relied on, nor in cases where the indications of respiration are obscure. See, however, inflation, p. 107.

† Casper, 'Handbuch, Fünfte Auflage,' Band II, p. 936-7.

a. The Organs of Circulation.—There exist in the foetus certain temporary additions to those organs of circulation which

Fig. 18.



are destined for extra-uterine life. These consist of the umbilical arteries (*a a*), which return the blood of the foetus to the mother; the umbilical vein (*b*), which conveys the blood of the mother, through the intervention of the placenta, to the fœtus; the ductus venosus (*c*), which conveys part of the mother's blood direct to (*h*), the ascending cava; the ductus arteriosus (*d*), which conveys the blood destined after birth to circulate through the pulmonary arteries (*k k*), direct into (*f*) the descending aorta; and the foramen ovale (*a*, fig. 19), situated at (*e*), which, by establishing a communication between the right and left auricle, makes the double heart of the future breathing animal, a single

one during the life in the womb. All these parts, being unnecessary to extra-uterine life, are closed after birth.*

Fig. 19.

The Umbilical Arteries and Vein.—The obliteration of the *arteries* takes place much sooner than that of the vein. At the end of twenty-four hours they present a marked contraction and thickening of their coats near the umbilicus. At the end of two days the contraction extends through a great part of their length, and at the end of the third day reaches nearly to their termination in the iliacs. The changes in the *umbilical vein* and *ductus venosus* occur much more slowly. During the first three days there is only a slight contraction; on the fourth this is more marked, and on the fifth it is, with few exceptions, complete.

The changes in the *ductus arteriosus* have been minutely described by Bernt of Vienna. The vessel is about an inch long, and about as large as the pulmonary artery. After a few respirations it contracts towards the aorta, but after some hours or days uniformly throughout. At the end of a week it has passed from the size of a goose-quill to that of a crow-quill; and on the eighth day is obliterated in half the children, and about the ninth or tenth in all.

The period of obliteration of the *foramen ovale* is extremely variable. Thus Billard found it closed in 1 out of 18 infants of a day old; in 4 out of 22 of two days; in 3 out of 22 of three days; and in 2 in 27 of four days old. Devergie confirms these observations as to the uncertain period at which the foramen is closed. It often continues open even in the adult, and, in some cases, without any dangerous consequences.

Bernt enters into minute details respecting the situation of the opening of the fossa ovalis at different intervals after birth; but these have no practical value. Indeed, the confidence formerly placed in the closure of the several fœtal vessels and of the foramen ovale, as signs of live-birth, and in the order and progress of obliteration in those parts respectively, as means of determining,

* In the diagram *g g* represent the iliac arteries, *i* the descending cava, and *l* the vessels of the portal system, derived from the umbilical vein.

with some approach to accuracy, how long a child had survived its birth, has been lately rudely shaken; for it has been shown that, on the one hand, all the vessels and the foramen ovale may be found open in children who have survived their birth several days; and, on the other, that the two parts on the obliteration of which the greatest reliance has been placed (the ductus arteriosus and the foramen ovale) may be closed within a few minutes after birth, or even, in rare instances, previous to it.

Of the patency of the fœtal vessels after live-birth a good example is given by Mr. Henry Lee, in his 'Pathological and Surgical Observations,' p. 116. The umbilical vein, ductus venosus, ductus arteriosus, and left umbilical artery, were all open, the right being closed only near the umbilicus, and yet the child from which the preparation was taken died from umbilical hæmorrhage when a fortnight old, and six days after the separation of the funis. Similar cases have been reported by Jörg and others. On the other hand, the little importance which attaches to the closure of the fœtal vessels and foramen ovale is shown by a case reported, by Dr. Norman Chevers, to the Pathological Society, January, 1847. The child had survived its birth only fifteen minutes, and yet the ductus arteriosus was found uniformly contracted so as only to admit the shank of a large pin, while its coats exceeded in thickness those of any other large vessel. Dr. Chevers thought that the contraction of the vessel took place before birth; an opinion which receives some countenance from the fact that the duct has been found absent. Of the very early closure of the foramen ovale, a remarkable case was reported by Mr. Smith, at a later meeting of the same Society (Dec. 7, 1847). The child died comatose at the end of sixteen hours, and the foramen ovale was found closed by a strong reticulated membrane firmly attached to its distinct annulus, impervious, and pouched. Dr. Chevers inclined to the opinion that in this case, also, the closure had taken place before birth.

The open state of the fœtal vessels and foramen ovale is therefore no proof of still-birth; and, on the other hand, the contraction of the ductus arteriosus and closure of the foramen ovale are quite consistent with a very short period of survivorship. The medico-legal value, therefore, of these tests of live-birth and survivorship is nearly on a par with that of the static lung-tests. The open state of the vessels affords a low probability of still-birth, and the contraction or closure of one or more of them of live-birth; but the length of time that the child has survived its birth cannot be safely inferred.

b. Changes in the Umbilical Cord.—In a new-born child the

umbilical cord is fresh, firm, round, and of a bluish colour; its vessels still contain blood; and its size varies with the amount of gelatinous fluid it contains. The *shrinking, withering*, or *mummification* of the cord is the first change: it commences at the ligature, and gradually extends to the navel. In some cases it begins directly after birth; in others not till some hours have elapsed; it is rarely delayed beyond thirty hours or two days, and never longer than three. The cord is now flabby, and sometimes a distinct red circle is perceptible round its insertion, with inflammatory thickening, and slight purulent secretion. The second change is *desiccation*. The cord first assumes a reddish-brown colour, and becomes semi-transparent; it is then flattened and shrivelled; and when the process is still more advanced it becomes quite transparent, and of the colour of parchment, the umbilical vessels being contracted, and containing clotted blood, or they are completely obliterated. This process of desiccation sets in from one or two to four days after birth, and it may be complete in from one to five days, but the usual period is three days. The next stage is the *falling off* of the cord: this usually happens on the fifth day. *Cicatrization* of the umbilicus, the last change, takes place about the tenth to the twelfth day. This description is based chiefly on the observations of Billard.

The changes in the cord of a child born dead, are merely the common consequences of putrefaction. Desiccation does not occur till after the latest period at which it takes place in the cord of a living child; and the cord does not separate, though the cuticle can be readily peeled off. Casper has shown that the first change (mummification) is not a vital process; but that it happens with portions of the cord cut off and exposed. He does not, therefore, attach to it "the slightest value as a proof of extra-uterine life!" But he considers the bright red ring surrounding the insertion of the cord, with inflammatory thickening, and slight purulent secretion, as affording "irrefragable proof of the extra-uterine life of the child." This red line requires to be distinguished from a narrower circle found in still-born children.

c. Change in the Skin.—This consists in an exfoliation of the epidermis, in scales, or as a fine dust, beginning on the abdomen, extending successively to the chest, groins, axillæ, interscapular space and limbs, and ending with the hands and feet. It may begin when the child is a day old, but may be delayed till the third or fourth day. It lasts, also, a variable period,—sometimes of thirty days, and sometimes of two months. It lasts longest in feeble and delicate children.

This, too, is a vital process, differing essentially from that

separation of cuticle which takes place in consequence of putrefaction. Although the period of its occurrence is variable, its existence affords clear proof that the child has survived its birth.*

The following table, based on Billard's observations, presents, at one view, the principal changes just described, the probable date of their occurrence, and the proportion of cases in which the foramen ovale and ductus arteriosus have been found open.

Days.	Umbilical Cord.	Foramen Ovale. Open per cent.	Ductus Arteriosus. Open per cent.	Umbilical Arteries.	Umbilical Vein.	Ductus Venosus.
1	Withering.	74	66	Open.	Open.	Open.
2	...	69	59	Obliteration advanced.	Open.	Open.
3	Desiccating.	64	69	Obliterated.	Open.	Open.
4	Separating.	63	63	...	Contracted.	Contracted.
5	...	45	52	...	Obliterated.	Obliterated.
8	Separation complete.	25	15			
10 to 12	Cicatrization commencing. Complete.					

The two questions—1. Was the child born alive? and, 2. If born alive, how long has it survived its birth? having been answered, we may have next to inquire,

HOW LONG HAS THE CHILD BEEN DEAD?

Post-mortem changes occur in the same order in the infant as in the adult. The animal heat first disappears, rigidity then ensues, and putrefaction follows. The body of the new-born infant parts with its heat very quickly; the rigidity is as great, and lasts as long in the infant as in the adult; and putrefaction, according to Devergie, goes on more rapidly. This difference will have to be borne in mind in making application of the principles laid down in a future chapter. (See Putrefaction, under real and apparent death). The effects of intra-uterine maceration, described at p. 88, must not be confounded with those of putrefaction.

* Billard: 'Maladies des Enfants,' pp. 13-24.

THE CAUSE OF DEATH.

There are several ways in which the life of a child may be sacrificed, within a short period of its birth, without violence on the mother's part: *a.* It may be immature or feeble; *b.* it may encounter obstacles to the continuance of respiration; or, *c.* a congenital disease may prevent the continuance of the vital functions.

a. The death of an infant after a few respirations, in spite of the most skilful and persevering attempts to restore animation, is an event well known to every accoucheur; and must be a common occurrence in children born under circumstances which preclude effectual assistance. The most common causes of early death are a long and tedious labour, hæmorrhage, continued interruption to the circulation through the cord; and immaturity or feebleness. It should also be understood that the causes which occasion still-birth promote the early death of children born alive. Thus more large infants perish in the birth, or die soon after, than small ones, and more males (as being larger) than females. Again, the danger to the child is greatest in a first pregnancy. It is probable, too, that in the absence of violence, or even of intentional neglect, illegitimate children would be specially liable to be still-born or to die soon after birth. The reports of obstetric practitioners show that, while the mortality of legitimate children is about 1 in 20, that of the illegitimate is about 1 in 10; the deaths of males being to those of females as about 7 to 5.

b. The chief obstacles to the continuance of respiration are such a position as shall cause the infant's mouth to be applied to some soft and yielding object, or to be immersed in blood, the discharges, or water; and the accumulation of mucus in the mouth, nostrils, and air-passages. Respiration may also be prevented by the child being born in the membranes.

c. The congenital diseases which prevent the establishment of the vital processes, or render their continuance for any length of time impossible, have their seat in the three organs most essential to life;—the heart, the lungs, and the brain.

Diseases of *the heart and large vessels* are rare in infancy; but such malformations as contraction or early closure of the fœtal vessels are important as affording a presumption of death from natural causes.

Diseases of the *lungs* are more important. They are six in number—1. Hepatization (red and grey), the consequence of pneumonia before birth. 2. Pulmonary apoplexy. 3. Tubercles. 4. Œdema. 5. A disease described by Devergie, as œdema lardaci-

forme. And 6. A state known as atelectasis. The three conditions of atelectasis, pulmonary apoplexy, and œdema lardaciforme are illustrated in portions of lungs in the annexed figure, of which 1. shows atelectasis as figured by Jörg. 2. The œdema described

Fig. 20.

and figured by Devergie. And 3. Pulmonary apoplexy from the lungs of a child three weeks old, one of several infants of the same family, that had died about the same age from embarrassed respiration.

These diseases may affect either the whole lungs or only a part. In the first case, respiration cannot be perfectly established, and the child cannot long survive its birth; when, however, the disease is partial, it will affect life, and shorten it in proportion to its extent.

The state of lung to which Dr. Jörg of Leipsig gave the name of *atelectasis* or imperfect expansion, is not, strictly speaking, a disease, but an absence of respiration and persistence of the fœtal condition, found to a greater or less extent in most new-born children, and continuing for days or weeks. The lungs in the unexpanded parts are perfectly healthy.

The chief diseases of the *brain and spinal marrow* are apoplexy, accumulations of fluid, and morbid softening. The apoplexy of the fœtus and new-born infant differ in no respect from that of the adult. M. Lasserre (Ranking's 'Retrospect,' vol. iii. p. 342) gives a case of meningeal apoplexy, a second of effusion of blood into the ventricles, and a third into the back part of the left hemisphere. A small quantity of serum between the membranes or in the ventricles, may be disregarded, but a considerable accumulation would afford a sufficient explanation of the premature death of the child. Morbid softening of the brain and spinal cord is another obvious cause of early death; but it must be borne in mind that the brain of the fœtus is naturally soft and vascular.

Of all the diseases just specified, it may be remarked that they are not of frequent occurrence; that when present, it is rarely to such a degree as to account for the speedy death of the child; and that it is only when proofs of respiration are present that these signs of death from natural causes have any significance.

In the case of children that have survived their birth but a short time, the absence of marks of violence affords a fair presumption that death was due to natural causes. It is true that the child may have died through intentional neglect—from the want of those simple aids by which the lives of children in more favourable circumstances are preserved—or by the simple closure of the mouth and nostrils; but these causes of death leave no distinct marks behind them, and the accused must have the benefit of the doubt that attaches to the case.

Was the Death due to Violence?—In answering this question we have to bear in mind the fact that fatal injuries may be the result of accident. But in some cases we may decide without hesitation that they were due to murderous violence. Punctured wounds of the fontanelles, orbits, heart, or spinal marrow; dislocation of the neck; separation of the head from the body; extensive fracture of the bones of the head and face; suffocation by plugging the fauces; or strangulation effected with unusual force tell their own tale. But there are other cases in which the nature and cause of the injury can only be determined by reference to obstetric experience and medico-legal experiments, illustrating the mechanical injuries a child may sustain during the act of parturition or immediately afterwards.

Suffocation.—Respiration, as already stated, is sometimes prevented or arrested by accidental causes which leave no mark of injury; so that it cannot be stated whether the child fell into the position of danger, was intentionally placed in it, or was allowed to remain there when it might have been rescued. This difficulty presents itself in a case of not uncommon occurrence. A child is found in a privy, and the question arises whether it was suffocated by being thrown into it, or expelled while the mother was there for a natural purpose. In such a case, if respiration is found to have taken place extensively or completely, there is a strong presumption against accident; while very imperfect respiration would afford an equally strong probability the other way.

Many cases of sudden parturition in such situations are on record; but they are rare in women who have not previously borne children. Jörg relates the case of a pregnant woman, who "on account of a desire to evacuate the bowels, went to the night-stool, and brought forth sitting on this, without any pain

or bearing-down, a large boy, who first struck the edge of the night stool with his head, and then fell on the ground."* There was extravasated blood on the left parietal bone. Mr. Tatham also mentions the case of a married lady delivered of twins on the night-stool. It was not her first labour, but probably her second. Both children died.† It must be admitted, then, as *possible*, that a fœtus found in a privy may have been suddenly discharged and suffocated. If the child so expelled fall into water instead of into night-soil (and generally when an infant is found in water), a question arises whether death was due to drowning, or the child was placed in the water to conceal some other mode of death.

Suffocation by such matters as mud, straw, feathers, wool, and wet linen thrust into the mouth, is not an uncommon cause of death. Whether the foreign substance could have been drawn into the mouth with the breath, or was intentionally introduced, must be determined by its quantity and compactness.

Infants are sometimes suffocated by rolling the tongue back into the throat. But as it would probably resume its usual situation, it is unlikely that this cause of death would be detected.

Strangulation.—A child may be strangled by a cord, and yet no marks appear on the neck. But even when there is a discoloured depression round the neck, it is not certain that this has been caused by the mother; for it might arise from the twisting of the navel-string, or by the pressure of the neck of the womb. The production of marks of strangulation by these causes has been denied, especially by Klein, who affirmed that he had never met with ecchymoses or suggillations produced by the orifice of the uterus, or by the umbilical cord, though he had known a great number of cases in which the neck of the infant had been strongly girded by the funis once or twice twisted round it, so as either to produce strangulation, or to render it imminent. But a case mentioned by Jörg shows that the experience of Klein is not to be implicitly trusted:—"The navel-string had been twisted five times round the neck, and had left five tolerably deep red impressions." Taufflieb also has reported cases of the same kind,‡ and there are several English cases to the same effect.

The mark produced by the navel-string is broad, continuous, grooved, rarely single, not excoriated, but sometimes consisting in parts of bloody extravasations. The contraction of the neck of the womb produces a broad depressed livid stripe.

The presumption of strangulation by the navel-string, may be

* 'Die Geburtshülfliche Exploration,' p. 116.
† 'London Medical Repository,' vol. i. part iv. New Series.
‡ 'Annales d'Hygiène,' vol. xiv. p. 340.

rebutted in those cases in which the cord is very short; for though it is usually about the length of the body itself (say 18 inches), it may be as short as 4½, and as long as 69, inches. (Churchill.)

Marks of pressure on the neck, therefore, cannot always be attributed to intentional violence; but as a murderer generally uses more force than is needful, they are too distinct to be accounted for by the accidental twisting of the cord round the neck. If the cord itself were used as a ligature, it would probably be applied with undue force. Moreover, the complete establishment of respiration would afford the strongest presumption against the strangulation having been produced by a cause acting during the birth. On the other hand, the absence of signs of respiration affords a presumption in favour of the constriction having been due to a cause acting before the birth.

It may be well to state that the twisting of the navel-string round the neck does not always occasion a fatal compression: for it appears from facts industriously collected in Germany, that the deaths attributable to this cause form about 1 in 38 of the cases in which it is present—results in striking contrast to those that follow prolapse of, and consequent pressure on, the cord, which is fatal in more than half the cases. It ought also to be understood that even when the cord is tightly drawn round the neck, death may not result from simple strangulation, but from interruption to the circulation through the cord. This interruption, however brought about, occasions efforts at inspiration to which Casper attributes the ecchymoses of the lungs, described at p. 91, and the filling of the air-tubes with liquor amnii.*

Strangulation may also be effected by the pressure of the fingers on the throat, leaving bruises corresponding with the cause.

Drowning.—The signs of this form of death are the same as in the adult. They will be described in a future chapter.

Fracture of the Skull.—This may happen:—1. Within the womb. 2. During labour. 3. By falls. 4. By criminal violence.

1. From cases cited by Casper (vol. iii. p. 109) it may be inferred that fractures of the fœtal skull may be occasioned by falls of the mother from a considerable height. Such fractures have, however, from the nature of the case, no medico-legal interest.

That the skull may be fractured during labour is proved by many well-authenticated cases. Siebold relates the case of a female with very narrow pelvis delivered, without assistance, of a well-formed still-born female child. On examining the head, a great quantity of blood was found on the surface of the cranium,

* See Casper's Handbook, vol. iii. p. 125.

and there were three fissures in the left parietal, and one in the left half of the frontal, bone. Michaelis of Kiel also reports the case of a woman with a well-formed pelvis, who was delivered of her first child after a natural labour. The child breathed during and immediately after birth, but then died. The head was much disfigured; and the right parietal bone, which during birth had been directed under the promontory of the sacrum, was covered anteriorly and above with effused blood, and on the removal of the periosteum was found fractured in five places. The whole of this bone was uncommonly thin. On opening the skull there was no extravasation beneath the fissures, but the longitudinal sinus was ruptured, and there was an extensive coagulum on the cerebrum on both sides, under the dura mater, and on the tentorium.* These two cases show how great an amount of injury the head may sustain during birth. But, as a general rule, fractures that take place during parturition are mere fissures, mostly situate on the parietal bone, and running at right angles to the sagittal suture. Less frequently they occur in the frontal bone, and run in a direction parallel to the suture. They are not attended by ecchymosis or laceration of the scalp.

Between these fractures of the skull and such as are the result of intentional violence, there is no essential difference, except in those cases in which unusual violence is used, and the fracture is minutely comminuted and accompanied by depression; or is not limited, as commonly happens with fractures caused by pressure of the womb, to the parietal and frontal bones, but extends to other bones of the skull, and even to those of the face. Defective ossification in the cranium of the new-born infant would explain the occurrence of fissures and fractures, without the necessity of assuming intentional violence.

3. Fractures of the skull caused by falls have been illustrated by some important experiments and observations. Chaussier found that in twelve out of fifteen still-born children let fall from a height of 18 inches on a stone floor, one or both of the parietal bones was broken. The same number of fractures occurred when the height was 3 feet and upwards, and in a few the injury extended to the frontal bone.†

But certain facts collected by Klein render it doubtful whether fracture ever occurs in sudden labours from falls on the floor. He procured returns of all such labours occurring in the kingdom of Würtemburg. They amounted to 183 well-authenticated cases, in 150 of which the mothers were suddenly delivered standing;

* These cases are quoted by Beck, Art. Infanticide.
† 'Considérations Médico-légales sur l'Infanticide,' par Lécieux.

yet there was not a single death among them, nor fracture of the skull, or other mischief; though some of the children had fallen on bare boards, and some on the pavement. The reason of the difference between Chaussier's experiments and these cases is supposed to be that, in the latter, the body of the infant is projected* obliquely, so as to break the fall. But cases reported by Casper show that the sudden expulsive power of the uterus must be set off against the causes that tend to break the fall. In no less than five instances the child is described as having been *shot* from the mother, and in one of them to have been *fatally injured*. This group of cases is also interesting as proving that, in rare instances, the height of the child's fall may exceed that of the distance from the genitals of the mother to the ground. The conclusion which Casper draws from his reading and personal observation is as follows:—"A parturient female may be surprised by the last act of birth in every position, even when erect, that the child may be thus forcibly expelled from her genitals, and may be thereby injured, particularly on its head, and that even fatally." (Handbook, vol. iii. p. 133.)

From certain facts collected by Dr. Cohen von Baren, it may be inferred that the presence or absence of fracture of the skull is largely determined by the state of the cord. Out of his 50 cases, 30 were born while the mother was standing, 17 while stooping or sitting, and 3 while kneeling. Of the 50, 32 were first-born, and 42 at full term. Of 19 infants born while the mother was standing, one only had fracture of the skull, and the cause of this was doubtful. But out of 25 cases in which the cord was ruptured, 5 presented fractures of the skull. Those fractures occasioned by falls can also be distinguished from those due to intentional violence only by the comparatively slight amount of injury contrasted with the great extent of that intentionally inflicted. When we find comminuted fractures of several bones—the parietal, frontal, and occipital—we are justified in attributing them to murderous violence.

When the umbilical cord is torn, it is generally found not to exceed, or even to fall short of, the usual length. The seat of the rupture is usually within one or two inches of the navel. If the cord, instead of being torn, is found cut through, it may be inferred that the injuries to the head were not due to accident. In any case, the state of the cord should be ascertained.

4. Fractures of the skull by intentional violence are characterized, as a general rule, by the undue force employed.

* Casper, it should be observed, takes exception to many of the returns on which these statements of Klein are founded.

Fracture and Dislocation of the Neck.—These injuries are never present before birth; and as they are not caused by falls, they may be taken as sure signs of criminal violence.

Contusions.—In reference to bruises on the head it must be borne in mind, that as compression of the head during labour occasions a livid swelling, such an appearance must not be attributed to criminal violence.

Incised and Punctured Wounds.—There is nothing peculiar in these wounds when inflicted on the new-born infant. For the distinction between them and other injuries inflicted during life and after death, the reader is referred to the subject of Wounds.

Poisoning.—This is a rare cause of death in new-born infants, though several cases of homicidal poisoning by the mineral acids have occurred in young children. They are characterized by the same appearances on the body and clothes as mark the action of those acids in the adult. It should, however, be borne in mind that in new born children the alimentary canal, in common with other important organs, is subject to disease. Sometimes the lining membrane of the *œsophagus* presents red spots, longitudinal lines, or ramifications. These, if arranged transversely, might be mistaken for the effects of a ligature applied to the neck. *The stomach*, moreover, as well as other parts of the alimentary canal, may be the seat of ulcerations with a sanguinolent, dark-coloured discharge. The rules for the examination of the stomach and intestines, and their contents, are the same for the infant and adult; and will be treated under the general head of Poisoning.

Infanticide by Omission.—The omission to tie the umbilical cord may prove fatal; and there can be no doubt that it is sometimes a criminal act. Foderé relates a case in which the child perished from the ligature becoming loose;* and Dr. Campbell reports two fatal cases, one from the accidental, the other from the intentional, removal of the cord.†

But the testimony of Klein and others that fatal hæmorrhage rarely follows *rupture* of the cord, proves that it is not necessarily the act of the mother; but may occur, as already stated, in sudden delivery in the erect posture.

The signs of death by hæmorrhage are the paleness of every part of the body, coupled with the small quantity of blood in the heart and large vessels. In the absence of wounds, this bloodless state may be regarded as the probable effect of hæmorrhage from the cord.

The child may perish by other acts of omission. The mother

* Vol. iv. p. 515.

† 'Introduction to the Study and Practice of Midwifery,' p. 151.

may have failed to provide proper clothing or food, to remove it from a position of danger, and to clear the mouth of mucus, or other accidental impediments to breathing. Death from want of food would betray itself by the great emaciation of the whole frame, and the empty state of the alimentary canal; and death by starvation and cold combined, by pallor of the surface, with congestion of the internal parts.

Cases of infanticide by omission are difficult of proof; and even when there are some marks of violence on the body, the inquiry is apt to assume so complicated a shape, that the jury cannot be induced to return a verdict of wilful murder.

EXAMINATION OF THE MOTHER.

The first inquiry with reference to the female suspected of having given birth to the child is,—Whether she has been recently delivered, and if so, whether the period of her delivery corresponds with the time at which the child is supposed to have been born. (See Delivery, p. 69.)

Another inquiry is sometimes necessary; and that is into the state of the mother's mind. Puerperal insanity is not a rare disease, and it may take the form of homicidal mania, threatening the life of the child, as in the following case quoted by Paris and Fonblanque.* A married woman, of good reputation, was delivered of a child, and not having slept many nights, fell into a temporary frenzy, and whilst alone killed her infant; but company coming in, she told them that she had killed it, and *there* it lay. The good reputation she had previously borne, the long want of sleep, and the entire absence of the usual motives to such a crime, added to "many circumstances of insanity appearing," led to her acquittal. Dr. Paris observes, in reference to this case, that "had this woman been of doubtful character, though innocent, she might have been executed for want of medical evidence to prove the nature and frequency of puerperal insanity."

A question of some importance in its bearing on infanticide, and having reference to the mother, is whether a female recently delivered, has the strength requisite for the destruction of her child. The answer is in the affirmative. Thus, Foderé relates the case of a French widow, who being seized with labour pains while receiving a visit from eight of her neighbours, complained of colic, and seating herself on a bucket in bed, as soon as the child's head passed the vagina, squeezed it flat by compressing it with her thighs. That a woman has strength enough to move about and exert herself after her delivery, is proved by the suc-

* 'Medical Jurisprudence,' vol. iii. p. 129.

cessful concealment of the fact of delivery, and of the dead infant, in the majority of cases brought to trial; as well as by well-authenticated instances of females walking several miles, or resuming laborious occupations, on the very day of their delivery.

This subject of infanticide will be best brought to a conclusion by the following summary of the chief points to be attended to.

1. Examine the body of the child to determine its degree of maturity, for this purpose weigh and measure it, ascertain the position of the centre of the body, and attend to the several points comprised in the description of the growth and development of the fœtus (p. 73). Note also any malformation that may be present.

2. Note the several circumstances by which the time that has elapsed since the death of the child may be determined, such as the presence or absence of animal heat and rigidity, the existence or non-existence of putrefaction, and, if putrefaction be present, the degree to which it has advanced.

3. Examine the entire surface of the body with a view to discover marks of violence, and, if any be present, determine whether they might have been produced during birth, or by accidental causes acting afterwards. Examine the mouth for foreign bodies introduced into it, and the fontanelles, orbits, heart, and nuchæ, in search of wounds inflicted by pointed instruments. Note the state of the umbilical cord, measure it, and ascertain whether it has been torn or cut; and observe the condition of the skin.

4. Open the chest, and remove the heart, lungs, and thymus gland. Separate the lungs, and carefully inspect their surface. Observe whether they are of a uniform liver-colour and compact consistence throughout, or uniformly spongy like the adult lung, or mottled with developed air-cells, as in imperfect respiration. If there are parts of a lighter colour than the rest, observe whether the texture of the lung is developed in those parts, and distinguish the developed cells from air the product of incipient or advanced putrefaction, by applying gentle pressure with the finger. In lungs free from putrefaction, the hydrostatic test may be resorted to, to ascertain their degree of buoyancy, as a rough measure of the quantity of air they contain.

5. Examine the heart and foramen ovale; the ductus arteriosus and venosus; and the umbilical arteries and vein. Observe whether these parts are contracted, and to what extent, or obliterated; and whether they contain much or little blood.

6. Examine the stomach to ascertain whether the child has been fed, using for this purpose the tests for sugar, milk, and starch; if there is any appearance of inflammation in the ali-

mentary canal, test its contents with a view to the discovery of poison. Note whether the intestines contain meconium and in what quantity, and whether the urinary bladder contains urine.

7. Examine the bones of the skull both at vertex and base, in search of fractures. Inspect the brain and its membranes, and note any effusion of blood or serum. Examine the spine with a view to the discovery of dislocation or fracture of the vertebræ.

8. Examine the suspected female in order to ascertain whether she has been recently delivered, and how long. In certain cases, inquire into the state of the woman's mind.

LEGITIMACY.

A child born in wedlock is presumed to have the mother's husband for its father; but this presumption may be rebutted by evidence of non-access, or of impotence.

There are several circumstances out of which the question of legitimacy may spring. 1. A woman may bear a child after her husband has been absent more than nine calendar months; and in this case the question arises, Does the period of utero-gestation admit of being extended beyond this the *usitatum tempus pariendi?* 2. A woman within a short period of her marriage may bear a child capable of being reared, and here the question arises, what is the earliest period at which a viable child may be born? 3. A woman before the expiration of nine calendar months from the date of her marriage, say in the 7th or 8th month, may be delivered of a child having the size and appearance of one at full term; and it may become a question whether being apparently so mature, it could have been of the supposed age. 4. A woman may give birth to a child during the life-time, or after the death, of her husband, he having been at the date of the conception in such a state of feebleness or disease, or imperfect convalescence from some severe malady, as to raise the question whether he could have been the father of the child. 5. A husband dies suddenly in perfect health, and shortly after his death his wife bears an immature child, and after an interval a second at full term or approaching maturity, and here the question arises whether the second child was the issue of a superfœtation. A question of paternity may also arise, where there is no doubt of the child's legitimacy, in consequence of the marriage of the mother to a second husband immediately after the death of the first. For cases of disputed legitimacy turning on the alleged impotence of the husband, see "Impotence," p. 36. The questions which fall to be examined in this place are chiefly—1. *The Duration of*

Pregnancy. 2. *The Viability of Children.* 3. *Superfœtation.*

I. DURATION OF PREGNANCY.

Though the practice of our courts of law is to consider forty weeks as the more usual duration, evidence is allowed to be given as to the possibility of that period being extended.

The period of utero-gestation in the human subject is generally stated at 9 calendar months, 10 lunar months, 40 weeks, or 280 days; and we often meet with the less definite expression "9 months, or 40 weeks." But there is a material difference between 9 calendar months on the one hand, and 10 lunar months, 40 weeks, or 280 days, on the other; for 9 calendar months may consist either of 273, 274, 275, or 276 days, falling short of 280 by from 4 to 7 days.

Another source of inaccuracy springs from the uncertainty attaching to more than one means of fixing the date of conception. These means are *four* in number. 1. *Peculiar Sensations* attending conception. 2. *Cessation of the Catamenia.* 3. *The Period of Quickening:* and 4. *A single Coitus.*

1. *Peculiar Sensations attending Conception.*—This mode of reckoning is open to the objections that these sensations are not so defined as to be recognised by those who conceive for the first time; that they are not constant in their occurrence in the same female; and that they do not take place at the exact time of the conception.

2. *Cessation of the Catamenia.*—To this mode of reckoning there are the obvious objections, 1. That the catamenia may cease from causes other than conception; so that a woman who, from some such cause, ceases to menstruate, and conceives immediately before or after the next suppressed period, may date the conception from the first period. 2. A woman may menstruate once, or more than once, after conception. In the first case the reckoning would exceed, in the second it would fall short of, the true duration. 3. That at the best it can give only an approximative result; for if we assume 28 days to intervene between the commencement of one menstrual period and that of the next, there may be an interval between the termination of one period and the beginning of the next of nearly 28, say 24, days. If conception be assumed to take place on the day *following* the cessation, and we reckon from the suppression, the calculation would fall short of the real duration by 24 days. If, on the other hand, we assume conception to take place on the day *preceding* the cessation, and we reckon from the last appearance of the menses, the calculated

would exceed the real duration by the same period of 24 days. To avoid this possible error of 24 days, the expedient has been resorted to of dividing the interval into two parts, and reckoning from the division. In this way the possible error is reduced to 12 days. In those cases in which the interval is contracted, either by the menses continuing for several days or recurring every three weeks, or every fortnight, the possible error would be less; and it would be greater in those in which the interval is prolonged to five or six weeks, or even two months.

3. *Period of Quickening.*—This starting-point is sufficiently condemned by the fact that quickening, when it is perceived, occurs at very variable periods, having a range of at least six weeks (from the 12th to the 18th), and if we combine the statements of several authors, of sixteen weeks, namely, from the 10th to the 26th.

4. *A single Coitus.*—This is the only accurate mode of reckoning; and well-attested facts of this class have now been collected in sufficient number to prove that the duration of pregnancy is subject to much variation, and to a marked excess above 280 days.

Fourteen such cases yield an average of 284, a minimum of 270, and a maximum of 293 days. The range was therefore 23 days, and the excess above 280 days 13, and 17 to 20 above 9 calendar months.

The inference drawn from cases in which the duration of pregnancy is fixed by a single coitus, is strengthened by analogous cases, in which the sudden death of a husband, or the date of separation from his wife, is used to determine not the exact but the minimum duration of pregnancy, conception being assumed to have taken place on the very day of death or departure. 27 cases in which the duration was thus fixed by single coitus, or by sudden death or departure of husband, gave an average of 284, a minimum of 260, and a maximum of 308 days.* The range was therefore 48 days, the excess above 280 days 28, and the excess above 9 calendar months, 32 to 35 days.

There is, therefore, the strongest reason to regard the period of utero-gestation as variable and not fixed; and also to expect increased divergence with an increase in the number of facts.

These views derive the strongest confirmation from the analogy of animals. Formerly their period of gestation was also held to be fixed; and it was stated to be 11 calendar months in the mare,

* The case of 308 days was supplied by Mr. Hewitt, a former pupil of King's College. The duration was ascertained by the sudden death of the husband. Cases of less than 260 days are excluded.

and 9 in the cow. But this is now ascertained to have been an error.

The well-known observations of M. Tessier, which extended to 102 mares and 160 cows, give the following striking results:—

	Mare		Cow	
Shortest:—	311 days.		241 days.	
Longest	394	„	„	308 „
Range	83	„	„	67 „
Excess above stated period	57 or 60	„	„	32 or 35 „
Average period .	„ 11 mths. 10	„	„	9 mths. 10 „

Earl Spencer made a still more extensive series of observations on 764 cows,* with these results:—

Shortest period (calf living)	220 days.
Shortest period (calf reared)	242 „
Longest period	313 „
Range (calf living)	93 „
Range (calf reared)	71 „
Excess beyond 260 days, before which time a calf was deemed immature . . .	53 „
Excess above 9 calendar months . .	37 or 40 „
Excess above 10 lunar months	33 „
Average duration	284 or 285 „

The majority of instances of gestation protracted beyond the average period, occurred in the case of bull calves, the numbers being, of cow-calves 90, of bull-calves 152.

These observations of M. Tessier and Lord Spencer prove that the period of gestation in the cow and horse, which, like that of the human subject, was formerly regarded as fixed, is not only variable, but that the extremes are widely separated, and the longest period in excess of the average by considerably more than a calendar month.

The case in favour of a variable period in the human subject admits of being strengthened by other arguments. All the functions of the human body that have been carefully examined, such as the cutting of the teeth, the pulse, the respiration, are found to vary within wide limits. So also with the functions more directly connected with pregnancy: the catamenia may appear at any age, from 9 years, or earlier, up to 23 or 24, or later; and they may continue up to any age from 35 to 55, or even later. They may also recur at intervals of a month, six weeks, or a fortnight, and the periods may comprise a variable number of days.

* See the 'British and Foreign Medical Review' for Jan. 1841.

Then, again, the period of quickening varies from the 10th or 12th to the 18th or 20th week, or even later; and child-bearing, which has usually ceased by 45, may occur as late as 54, and possibly at a still more advanced age.

Another argument of no slight force in favour of a variable period, and of its possible extension beyond the limit usually assigned, is found in the fact that the advocates of a fixed period are not agreed among themselves as to what that period is. Of the seventeen medical men examined in the Gardner Peerage case, five advocated a fixed period, and opposed the idea of protracted gestation; but all of them, with the exception of Sir Charles Clarke, who fixed it at 40 weeks or 280 days, stated the duration differently, and were forced to admit a greater or less deviation from a fixed standard. Dr. Gooch stated it at from a day or two before to a day or two after 9 calendar months, and Dr. Davis at a day or two under 9 calendar months; while Dr. Blegborough allowed an interval of from 39 to 40, and Mr. Pennington of from 37 to 40 weeks.

But while five of the seventeen medical men supported the opinion that the period of gestation was fixed, or nearly so, twelve believed that it might be protracted to $9\frac{1}{2}$, 10, or 11 calendar months, or (288—290) (304—306) (334—337) days.

The balance of authority, both ancient and modern, may be also adduced in support of the theory of a variable period, and of possible extension of pregnancy beyond the 280 days.

To the foregoing arguments may be added the fact, that legal decisions in this country have been favourable to protracted gestation, and that the same may be said of the decisions and even of the laws of other countries. Thus the Code Napoleon allows 300, and the Prussian law 302 days, and there has been a decision in the United States in favour of 317 days.*

The period of utero-gestation, therefore, being subject to variation, and admitting of extension beyond 280 days, a question now arises as to the limit of that extension. What is the longest possible duration of pregnancy?

The 14 cases fixed by a single coitus give, it will be seen, a maximum of 293 days; while the 27 based jointly on a single coitus, and the death or absence of the husband, extend the period to 308 days. One of two cases by Prof. Simpson brings the figures up to 313 days, and two cases by Murphy up to 314 and 324 days respectively.

The question, of the extent to which the period of utero-gestation may be protracted beyond 280 days assumed a definite shape

* 'American Journal of Medical Science,' October, 1845.

in the celebrated Gardner Peerage case, of which the following is a brief outline.

In the month of March, 1796, Alan Hyde Gardner, afterwards Lord Gardner, a captain in the navy, was married to Miss Adderley; and they cohabited as man and wife till January, 1802, (except during the occasional absence of the husband). On or about the 30th of January, Captain Gardner took leave of his wife, sailed a few days afterwards for the West Indies, and did not return to England till the 10th of July in the same year, his wife remaining in England during the whole of that period. Towards the end of the year 1801, when Captain Gardner was absent on his Majesty's service, his wife entered into an adulterous conversation with Henry Jadis, Esq., which Captain Gardner did not discover till June, 1803; after which time he did not have any intercourse whatever with his said wife. On the 8th of December, 1802, she was, without the knowledge of Captain Gardner, delivered of a male child, afterwards baptized by the name of Henry Fenton Gardner. In Easter Term, 1804, Captain Gardner brought his action in the Court of King's Bench against Henry Jadis, for criminal intercourse with Maria Elizabeth Gardner, and obtained a verdict for 1000*l.* damages. He also obtained a sentence of divorce in the Consistory Court, and the marriage was subsequently dissolved by Act of Parliament. Baron Gardner died on the 30th December, 1808, leaving Captain Gardner his eldest son and heir, who thereupon succeeded to the barony, as Alan Hyde, Lord Gardner. On the 10th of April, 1809, he was married to the Honourable Charlotte Smith, daughter of Lord Carington, and by her had issue an only son, Alan Legge Gardner, born on the 29th of January, 1810, and one daughter. Alan Hyde Lord Gardner died the 27th of December, 1815, leaving Alan Legge Gardner successor to the title. Henry Fenton Gardner attained the age of twenty-one in the month of December, 1823; and Alan Legge Gardner, being an infant of about fourteen years of age, petitioned his Majesty for a recognition of his right to the title by letters patent, or by ordering his name to be entered on the Parliament Roll as a minor peer.*

It was proved on the trial that there was a possibility of access on the 30th of January, 1802; from that date to the 7th of February, and on or after the 11th of July. Hence the three questions proposed to the medical witnesses:—

1. Could a child born on the 8th of December have been the

* This account is abbreviated from Le Marchant's history of the case.

fruit of sexual intercourse on the 30th of January, being 311 days?

2. Could a child born on the 8th of December have been the fruit of sexual intercourse on the 7th of February, being 304 days?

3. Could a child born on the 8th of December, and living to manhood, have been the fruit of sexual intercourse on or after the 11th of July, a period of 150 days, or two or three days short of five calendar months?

The first two questions may be reduced to one, so as to give the following alternative:—if the child were legitimate, he must have been either a 150 days' child, or a 304 or 311 days' child (one calendar month and two or nine days beyond the *usitatum tempus pariendi*). The latter alternative, viz., gestation protracted to the 304 or 311 days, was the one chiefly insisted on in this celebrated trial. The case was not decided by the medical evidence, but by the adultery of the mother of Henry Fenton Jadis. This having been proved, the claim of the petitioner, Alan Legge Gardner, was allowed.*

II. VIABILITY OF CHILDREN.

The question, What is the shortest period of gestation at which a *viable* child may be born? was raised in the Jardine case, which, though less known than the Gardner Peerage case, is equally interesting, as no less than 14 medical men, and a still greater number of non-professional witnesses gave their evidence. In this case, too, there was great difference of opinion among the skilled witnesses. The evidence of Drs. Alison and Christison was admitted as Lecturers on Forensic Medicine, whose attention had been directed to the question involved; and it may be safely affirmed, that Dr. Christison threw more light upon the case than all the other witnesses put together.

The following is a short abstract of this case:—

The defendant was married on the 3rd of March, 1835; and on the 24th of August following, his wife was delivered of a girl, who, supposing her to have been the fruit of sexual intercourse on the day of the marriage, was only 174 days, or 5 calendar months and 21 days old. The infant, which was undoubtedly immature, though to what degree could not be determined, died on the 20th of March, 1836, having survived about seven months.

The libel charged the defendant with having committed fornication with his wife before marriage. A great many witnesses

* For fuller particulars consult Dr. Lyall's summary of the 'Medical Evidence relative to the Duration of Human Pregnancy, as given on the Gardner Peerage Case.'

were called, some to prove the possibility of sexual intercourse before marriage, others to show that the child, though small and feeble, was not immature, or at least not so immature as the date of the marriage would make it; and others to speak to the impossibility or improbability of a child surviving at that early period. The extent to which the allegations of the libel were made good, and the vague nature of the evidence adduced in their support, will appear by the following extract from the decision of the Presbytery, November 7th, 1838:—"That the testimony of the several witnesses, both with respect to matters of fact, viz., the appearance of the child at birth, &c., and also with respect to the opinions of medical men regarding the viability of such a premature child as the child in question is said to be, is of such an opposite and contradictory nature, that the Presbytery, with their present light, have great difficulty in coming to any decision on these points. The Presbytery, therefore, agreeably to a common maxim of law, *Satius est impunitum relinqui facinus nocentis quam innocentem damnari*, find the libel not proven."*

The principal points established by the general and medical evidence in relation to Mrs. Jardine and her infant were, that she had menstruated as usual the week previous to her marriage; that she was, both before and after her marriage, in a very weak state of health; that she was herself a seven months' child; that she had a second child, a daughter, which she believed to have been born "just about the commencement of the eighth month of her pregnancy," and that she had not provided baby-linen for this child. As regards the infant, the evidence, though contradictory on many points, showed that it was small (it weighed three pounds when born), very feeble, and decidedly immature, though no data were adduced to show the degree of immaturity. It required to be nursed with care, but not with those extreme precautions for preserving warmth, which seem to have been absolutely necessary in the cases of Drs. Rodman and Outrepont, presently to be described.

The special question raised in the Jardine case was this—Could a child born 174 days, or five calendar months and twenty-one days, after marriage, be reared to the age of seven months? and the general question suggested by the case is—What is the earliest period of gestation at which a viable child may be born?

* 'Record of the Proceedings in the reference by the Synod of Fife, to the Venerable the General Assembly of the Church of Scotland, in May, 1839, of the Case of Mr. Thomas Barclay, Town Clerk, and Nine of the Parishioners of Kinghorn, against the Reverend Fergus Jardine.' Edinburgh, 1839.

Now it is universally admitted that a child may be born and reared to manhood as early as the seventh month; and as generally believed that a viable child cannot be born before five calendar months, or 150 days.

To test the soundness of this opinion, and to ascertain the earliest date at which a child may be born alive and reared, we must consider two distinct orders of facts. 1. Facts which afford a presumption in favour of early viability by showing that infants born alive at an early period have survived a few hours or days; and 2. Facts of the same order relating to infants that have been reared to adult age, or to such an age as affords reasonable presumption in favour of their having attained that age.

1. To this first class belong such cases as those of Mr. Thomson,* in which an infant of the estimated age of 5 months, survived 3½ hours; of Christison,† in which one of 167 days old survived 8½ hours; of Bucholtz,‡ in which one of 189 days old survived 2 days; of Kopp,§ in which one of 182 days survived 4½ days; and of Fleischmann,‖ in which one of 168 days survived 8 days.

Dr. Bonnar¶ has compiled a table comprising no less than 112 cases of infants born alive at periods varying from 120 to 210 days; and if from this collection of facts, more or less well authenticated, we omit 39 cases of infants born at 210 days, and about which there need be no dispute, there remain 73 infants born alive at various ages from 198 down to 120 days. Of these 9 had attained ages from 191 to 198 days; 4 had reached 190 days; 3 from 183 to 189; 38 were 180 days old; 3 from 174 to 178; 5 from 165 to 168; 1, 158; 8 of the age of 150 days; and 5, various ages from 120 to 147 days. Out of the large group of infants born at 180 days, 18 survived their birth from 5 minutes to 16 hours; 6 lived one day; 3 from 5 to 11 days; 1, six weeks; 2, four months; and the remainder (7 in number) 1 year, 2 years, and 15 years respectively. Of the 8 infants of the reputed age of 150 days, 2 barely lived, two lived 3 minutes; one, 2 hours; one, 24 hours; one, 6 days; and one, 19 years. The group of five cases born prior to the 150th day comprises one of 120 born alive; one of 125 surviving six hours; one of 147, living 12 hours;

* Of Alva, Stirlingshire, quoted by Beck.

† Evidence in the Jardine case.

‡ Beiträge ii. 104. § Jahrbuch, iii. 128.

‖ Henke's Zeitschrift, vi. 12.

¶ 'A Critical Inquiry regarding Superfœtation, with cases.' By George Lindsay Bonnar, M.D., Cupar, Fife: 'Edinburgh Medical Journal,' January, 1865.

one of 133 (Rodman's case), 21 months; and one of 135 (Capuron's case of Fortunio Liceti), living to 80 years of age!

The second class comprises the three leading cases by Rodman, Outrepont, and Belloc, which will presently be more closely examined. Of the facts of the first order it may suffice to state that there is nothing in the accompanying history of weights and measures to militate against the authors' estimates of the period of gestation at which the several infants had arrived; while, on the other hand, in the Jardine case, the weight of 3 lbs. stated to belong to a child born at 174 days, or before the completion of the 6th month, is a pound in excess of the highest weight of any of the five infants in the first group; and exceeds the weights given at p. 77, with the exception of the very doubtful instance of 3 lbs. 13 oz.

But small length and weight are but two signs of immaturity among several which are at least equally deserving of attention, such as the high position of the centre of the body, the disproportionate size of the head, and wide separation of the fontanelles; the presence of the membrana pupillaris; the non-descent of the testicles; the prominence and deep red colour of the parts of generation; the intense red colour, mottled appearance, and downy covering of the skin; the nails not formed; the scanty deposit, or total absence, of sebaceous matter on the skin; the feeble movements and cries; the inability to suck; the necessity of artificial heat; the almost unbroken sleep; the rare and imperfect discharges of urine and meconium; and the closed state of the eyelids, mouth, and nostrils.

These, on the other hand, are signs of maturity:—

Strong movements and cries as soon as the child is born; the body of a clear red colour, and well coated with sebaceous matter; the mouth, nostrils, eyelids, and ears perfectly open; the skull having some firmness, and the fontanelles not far apart; the hair, eyebrows, and nails perfectly developed; the testicles descended; the free discharge of the urine and meconium a few hours after birth; and the power of suction, indicated by the seizure of the nipple or a finger placed in the mouth.

By comparing these descriptions with some of the more remarkable recorded cases, we shall see that there is reason to believe in the occasional survivorship of very immature infants. Of the three cases mentioned in group 2, the cases of Drs. Rodman and Outrepont are deserving of special consideration.

Dr. Rodman, after describing the mother as "cautious," "accurate," and trustworthy, and stating that she had borne five children, and "was confident that the period of her gestation was

less than nineteen weeks," says, that premature labour was brought on by fatiguing exertions, and that she was delivered of a living male infant.

Not daring to wash the child, it was quickly wiped and wrapped in flannel, with only an opening near the mouth for the admission of air; and it was taken into the warm bed with the mother. Though the child was weak, no feeding was attempted till after the lapse of twelve hours. "The nourishing heat with the mother in bed was relied on." The next day, the head, body, and extremities were surrounded with fine cotton-wool, pressed like cloth, to the thickness of two or three rolls, and over that the flannel as before; and again the child was given to the mother in bed. Even with this dress, he could not be kept warm enough; and as he soon became weaker when exposed to the heat of a fire, whilst the warmth of the mother enlivened and strengthened him, he was kept warm, by the mother and two other females lying in bed with him by turns for more than two months. After this he could be left alone from time to time, but was still undressed very cautiously. It was not till he was three weeks old that the length and weight of the body could be ascertained. The *length* was found to be 13 *inches*, the *weight* 1 *lb.* 13 *oz. avoirdupois*. It was extremely difficult to get the child to swallow nourishment the first week; the yellow gum soon came on, and the thrush seized him severely on the eighth day, and lasted till the end of the third week. During the first week he was fed with two or three teaspoonfuls of toasted bread boiled with water, sweetened and strained through fine linen; in the second week twenty drops of beef-tea were added, and small doses of castor-oil were administered. At the end of three weeks he began to swallow teaspoonfuls of his mother's milk, and two days after made efforts to suck. The mother's milk was gradually substituted for the panada, which was still given occasionally with a few drops of port wine. Under this careful management he attained the age of four months, and his health and excretory functions were peculiarly regular. Five months after this, as we find from a second paper by Dr. Rodman,* this child was still doing well. In this paper he describes the mother as tall, robust, and healthy, and again states that she had a peculiarly accurate knowledge of the time of her previous gestations, and did not hesitate still to affirm, that the period in this instance was rather under nineteen weeks.†

* 'Ed. Med. and Surg. Journal,' vol. xii.

† Case of a child born between the fourth and fifth month, and brought up. By John Rodman, M.D., Paisley, 'Ed. Med. and Surg. Journal,' vol. xi. p. 446. The facts of this case were attested by Mr. White of Paisley.

Dr. James Hamilton, in his evidence in the Jardine case, states that this infant lived a year and nine months; but that from circumstances mentioned to him by Dr. Rodman, he had always thought that there was some mistake in the woman's reckoning, and that the infant was a dwarf, being considerably smaller than those puny infants born within the six months, whom he had seen drag on a miserable existence for four or five days.

It must be admitted that, in this instance, an extremely feeble and immature child was reared by very judicious treatment, and that the mother's estimate of the age was at least as likely to be correct as such estimates ever can be. The length and weight of the child, too, are in keeping with the other lengths and weights given at p. 74, and they will be found to coincide with the extreme weight and length of the tables at pp. 77, 78. The absence of any description of the appearances presented by the child prevents us from determining its degree of immaturity. It might have been a five months' child, but there is no ground for supposing it to have been born before the completion of the fifth month.

The case related by Dr. Outrepont, of Bamberg, is very valuable, for it is the only quite unequivocal instance on record of the rearing of a six months' child. The particulars are given so fully, and with such precision, that even Henke, who previously denied the possibility of such an incident, candidly admitted that Outrepont's case is an unequivocal example.* The evidence is complete both as derived from the date of impregnation, and from the structure and history of the child. The mother, a young woman, who had always been perfectly regular, menstruated as usual ten days after her marriage, and was subsequently repeatedly connected with her husband. About a fortnight after this menstruation, she became changed in appearance, and, for the first time in her life, had frequent attacks of vomiting and fainting. These symptoms continued, but the catamenia did not return: and about twenty weeks after their last appearance, she felt the first movements of the child. Five weeks after this she was seized with labour-pains and hæmorrhage; and Dr. Outrepont, having ascertained that this proceeded from the placenta being attached to the os uteri, encouraged the labour, and brought it to a prosperous conclusion. The evidence of this child being not more than twenty-five weeks old, is as strong as it is reasonable to expect. The state of the child at birth was still more unequivocal. It was a boy, and breathed

* 'Zeitschrift,' vi. 27.

immediately on being born; measured thirteen and a half inches, and weighed one pound and a half. Its skin was covered with smooth lank down, and was much wrinkled. The extremities were extremely small in proportion to the trunk, and were kept constantly bent over the body, as in the fœtus in the womb. The nails of the fingers and toes were like white folds of skin, the testicles were still within the belly, and the pupillary membrane was entire. The child whined but could not cry; slept almost constantly; woke only once a day; seldom opened its eyelids, and was obviously insensible both to light and sound. The first discharge of urine took place on the seventh day, and the first evacuation of the bowels on the ninth. Subsequently the urine was voided once in forty-eight hours, and the fæces every two or three days. The child was placed in a basket filled with wool, kept in a uniform temperature, and moved with great care. For some time it was fed with the spoon on diluted milk and sugar. In four weeks the down began to drop off from the skin. In fifteen weeks the wrinkles had disappeared from the skin, and the length was increased an inch and three quarters. From this time, which corresponded with the fortieth week after impregnation,—that is, with the full period of utero-gestation,—it made rapid advances; sleeping less, eating more, crying strongly, and becoming evidently sensible to sound, and pleased with the light. When fourteen months old, it was of the weight and stature of a child born at full term. In the eighteenth month, the testicles descended into the scrotum. The teeth began to appear early in his third year. He did not begin to walk till half a year later; and then differed from other children of the same age, not only in size, but also in the singularly old expression of his countenance. When Dr. Outrepont saw him in 1816, he was eleven years of age, was as big as a boy of seven or eight, and had just begun to read and write.*

In this case also the length and weight are in keeping with the lengths and weights given at p. 75, and much within the extremes given in the tables at pp. 77, 78; and the signs of immaturity are so well marked and so minutely described as to be decisive of the possibility of rearing a child born before the end of the sixth solar month, or 26 weeks.

III. SUPERFŒTATION.

Superfœtation means the conception of a second embryo during the gestation of the first, the products of the two conceptions being born either at the same or at different times.

* This case is taken from Dr. Christison's evidence on the Jardine case

Some light is thrown upon this question by more than one well-authenticated case in which a woman has been delivered of twins of different colours, both fully formed. The following are taken from many similar ones quoted or referred to by Beck:—A female at Charleston, in South Carolina, was delivered in 1714 of twins, within a very short time of each other. One was black, and the other white. She confessed that on a particular day, immediately after her husband had left his bed, a negro entered her room, and by threatening to murder her, had connection with her. This case is related on the authority of Buffon. Dr. Moseley mentions the following as occurring within his time at Shortwood estate, in the island of Jamaica:—A negro woman brought forth two children at a birth, both of a size; *one a negro, the other a mulatto.* She explained the occurrence by stating that she suffered the embraces of a white man belonging to the estate directly after her black husband had quitted her. A case of triplets of three different colours may be omitted as resting on insufficient authority.

These are cases in which the two mature children are brought into the world differing in nothing but colour from children of one father and one conception. There is another class of cases equally easy to believe and understand, in which the birth of two children is separated by a short interval, or by an interval closely corresponding to their relative size and development, on the supposition of their being twins. Of the former class of cases the following, cited by Beck, from the *Consilia* of Zacchias, is an example:—J. N. Sobrejus lost his life in a quarrel, leaving his wife pregnant. Eight months after his death she was delivered of a still-born deformed child. Her abdomen remained large, and was supposed to contain a second infant, but the efforts made to procure delivery proved fruitless. One month and a day thereafter, the widow was again taken in labour, and brought forth a perfect living child. The relations of the husband contested its legitimacy, on the ground that it was the fruit of a superfœtation, and Zacchias was consulted. He agreed that the two infants could not have been the product of one conception, since the interval between their birth was so great: but gave it as his opinion, that the *first* was the product of a superfœtation, and conceived a month after the other. As the husband died suddenly while in a state of perfect health, his opinion preserved the

with alterations and additions suggested by the perusal of the case in the 'Zeitschrift für die Staatsarz,' vi. 19. It may be well to state that Dr. Christison admitted the possibility of a child born after 174 days being reared.

character of the mother, and her legal rights. Zacchias seems, in this case, to have chosen the most improbable of two suppositions; for it is certainly more easy to suppose that the birth of twins, the product of the same conception, may take place at two different times, than that they should be the products of two different conceptions; and it is difficult to understand on what data he based his opinion that the child first born was the last conceived. In all such questions, the wisest course is to prefer that interpretation which involves the least difficulty, and is most consistent with experience. Now the expulsion of twins at different times is allowed to be a common event, of which examples are to be found in most works on midwifery. The most feasible opinion, then, seems to be, that this was a case of twins conceived at the same time, but of which one died, and was discharged, before the other.

But there are cases which do not admit of so easy an explanation, and which certainly countenance the theory of a double conception.

The wife of Raymond Villard, of Lyons, married at twenty-two, and became pregnant at the end of five years, but had an abortion at the seventh month, on the 20th of May, 1779. She conceived again within a month; and on the 20th of January, 1780, eight months after her delivery, and seven months from her second conception, she was suddenly delivered of a daughter. This delivery was not, however, followed by the usual symptoms—no milk appeared, the lochia were wanting, and the abdomen did not diminish in size. It was accordingly found necessary to procure a nurse for the child. Two surgeons who visited the female were at a loss with respect to her situation, and consulted Desgranges, who declared that she had a second child in the womb. Three weeks after her delivery she again felt the motions of a fœtus; the abdomen again increased in size, and on the 6th of July, of the same year, 1780 (five months and sixteen days after the first birth), she was again delivered of a living daughter. The milk now appeared, and she was able to nurse the child. Desgranges, after stating his firm conviction that these two children were conceived at an interval of some months, adds, that this second child could not have been conceived after the delivery of the first, inasmuch as no sexual intercourse took place between the husband and wife till twenty days after, which would have made the age of the second child only four months twenty-seven days. On the 19th of January, 1782, the mother presented the two children, with extracts from the baptismal register, before two notaries of Lyons, in order to attest the facts above stated.*

* Foderé, vol. i. p. 485.

Assuming the facts of this case to be correctly stated, it must be admitted to be nearly conclusive as to the possibility of superfœtation; for if we deny this, and assume both children to have been the product of a simultaneous conception, and the last child to have been at full term, the first, which, be it observed, in common with the other survived its birth between one and two years at the least, must have been born alive at three months and a half: or, if the first child be admitted to be seven months old, the second must have been born alive at six weeks. The alternative supposition, that the second child was the fruit of sexual intercourse subsequent to the delivery of the first, is also in the highest degree improbable, for it supposes a child, born before the completion of the fifth month, to be reared, and that without any difficulty. The only remaining supposition, namely, that the second child was a twin born after a gestation of twelve months and a half, presents equal difficulties.

Dr. Maton has also related a well-authenticated case, in which two male children (both "born perfect") were brought forth at an interval of nearly three calendar months. If this had been a case of simultaneous conception, the age of the one would have been six months or less, that of the other nine months or less.

Additional cases are referred to by Beck, in three of which there was an interval of one month, in two an interval of two months, and in one an interval of four months; and Dr. Bonnar cites Velpeau for a case in which an infant "thought to be at full time," was born five months after "a child at the *full time*."

In deciding this question, those cases only must be admitted to have any weight in which the interval between the births is considerable; for, where it is short, if we suppose the child last born to be mature, the first may have been eight or seven months old, which is quite reconcilable with the supposition of its being reared. When, however, the interval is of four months, if we assume, as before, that the child last born is mature, the first cannot be more than five months old, an age at which it is in the highest degree improbable that a child could be reared at all, and certain that it could only be saved by ingenious and careful contrivances of which mention is sure to have been made.

In any cases that may hereafter occur, it will be important to observe the size and development of the children. But it must not be forgotten that even the healthy products of the same conception may differ greatly in size—a fact well illustrated by a case brought under my notice by Mr. Streeter, in which female twins, five and a quarter months old, were born enveloped in a common chorion. The one was more than twice the size of the

other, but the smaller alone had made successful efforts to respire. (G.)

If the single case of the wife of Raymond Villard be correctly stated, the doctrine of superfœtation must be admitted to be established; but it may be useful to subjoin the chief arguments employed by the advocates and opponents of that doctrine.

The opponents of superfœtation allege that the occurrence is impossible, because 1, shortly after conception the os tincæ, as well as the internal apertures of the Fallopian tubes, are closed by a thick tenacious mucus. 2. The membrana decidua, which is also formed soon after conception, lines the uterus, and aids in obliterating the openings into its cavity. 3. When the uterus is impregnated, the Fallopian tubes, instead of running horizontally to the ovaria, lie parallel to its sides, so that if a second embryo were formed within the ovarium, the tubes could not embrace and convey it to the uterus. And 4. that the new embryo would destroy the first.

The last objection is founded upon a bare assumption, and may therefore be summarily dismissed. The third objection, if valid, must prove fatal to the doctrine of superfœtation; but though this obstacle may exist in the fully-developed uterus, the ovary and Fallopian tubes are not more prevented from coming into contact with each other in the early stage of utero-gestation, at which alone superfœtation is alleged to take place, than in the unimpregnated state. The answer to the first two objections is obvious. Neither the tenacious mucus nor the newly-formed decidua, though in contact with the orifices and cells of the uterus, adheres so firmly to it as not to admit the passage of the semen. The fact of menstruation in numerous cases occurring during a part or the whole of pregnancy, seems to prove that the adhesion of this tenacious mucus and of the decidua is by no means so firm as to forbid the passage of fluid; and this argument is strengthened by the frequent occurrence of hæmorrhage in the advanced stages of pregnancy in consequence of partial detachment of the placenta. The arguments advanced against the doctrine of superfœtation are therefore not of sufficient weight to counterbalance the improbabilities set forth in the case of Raymond Villard; and unless that case can be shown to be untrustworthy, there seems to be no alternative but to admit the truth of the doctrine.

If, then, we admit the possibility of superfœtation, the question arises, Can we explain this occurrence so as to avoid the objections of its opponents? The existence of double uteri, and more rarely of double vaginæ also, suggests the required explanation;

and as the recorded cases of this malformation are much more numerous than those of superfœtation, it is quite possible that some of the latter may be explained by the malformation in question.*

That this malformation does really explain some cases of superfœtation, is proved by a case related by Scheider of a woman who, six weeks after marriage, bore a four months' child, and forty weeks after marriage mature twins. On examination, the uterus and vagina were both found double, and each vagina had a separate orifice.†

Dr. Bonnar, in the Essay already referred to, raises a novel question of much interest in itself, and obviously admitting of practical application, namely, how soon after her delivery may a woman again become pregnant. Starting from the common assumption that at least thirty days must elapse before the uterus can resume its generative function, and adding from 274 to 280 days for the period of gestation, it would follow that no woman could bear a mature child sooner than the 304th, or from that to the 310th day. Dr. Bonnar, by referring to 'Lodge's Peerage and Baronetage,' shows that there have been at least 19 recorded cases, in which the interval between one birth and another has been 309 days or less. There were ten cases of 309 to 300 days; 2 of 299 to 290; 4 of 289 to 280; 1 of 273; 1 of 252; 1 of 182; 1 of 173; and 1 of 127 days. Dr. Bonnar, taking these cases into consideration, and weighing the facts relating to the state of the vagina, uterus, and lochial discharge, fixes on the *fourteenth* day after delivery as the earliest at which a fresh impregnation may take place.

Having discussed at length the three leading questions connected with the subject of legitimacy, it will be necessary to say only a few words on some questions of less interest and importance.

The question of paternity, as already stated, may arise when a woman, soon after the death of her husband, marries again. Sometimes this question assumes the shape of the one last discussed. A child is born within five months, or thereabouts, of the death of the first husband, and the question of paternity becomes one of viability. Where the child is of such an age as that it might have had either husband for its father, the paternity must be decided by a reference to the state of health of the deceased husband at the presumed time of conception.

* Dr. Cassan ('Recherches sur les Cas d'Utérus Double, et de Superfœtation') has collected 41 cases, in three of which both uterus and vagina were double; and Beck has added 11 others, in three of which the vagina was double.

† Müller's 'Archives,' 1836, and 'London Med. Gaz.,' vol. xx. p. 408.

Another class of questions, of little importance and rare occurrence in this country, may arise in slave-holding states, where the reputed parents of a child are of different colours, and the offspring differs in appearance from the majority of children of mixed marriages.

Some discussion has taken place as to the kind and degree of evidence of live-birth necessary to establish a right of inheritance under the tenure known as 'tenancy by the curtesy.' "When a man marries a woman seised of an estate of inheritance, and has by her issue born alive, which was capable of inheriting her estate. In this case he shall, on the death of his wife, hold the lands for his life, as tenant by the curtesy of England." The meaning of the expression *born alive*, is not the same in this case as in cases of infanticide. It has been decided that in questions of tenancy by the curtesy, any kind of motion, even "a twitching and tremulous motion of the lips," as in the case of Fish *v.* Palmer, tried in 1806, is held to be sufficient evidence of live-birth.

The question how far monsters are capable of inheriting, has been raised, and answered by Blackstone, who states that "a monster which hath not the shape of mankind," "hath no inheritable blood;" but if, in spite of deformity, "it hath human shape, it may be an heir."

CHAPTER IV.

LIFE-ASSURANCE. FEIGNED DISEASES.

LIFE-ASSURANCE.

MEDICAL men have to perform important functions in relation to life-assurance. Applicants for insurance are submitted to the inspection and examination of physicians or surgeons selected for the purpose, and their ordinary medical attendants are consulted respecting the diseases from which they may have suffered. The services of the medical man are especially required by those offices which undertake the insurance of unsound lives, or which are in the habit of accepting lives that fall short of the standard of robust health; for all information respecting special risks must be drawn from medical sources. In the best managed offices, again, medical men of standing and experience occupy places on the board, and by affording information respecting the meaning of terms, and the true significance of statements contained in the reports submitted, are able to render very important service. Medical men are also called upon to report on injuries sustained by persons assured against accident, and they have to render similar services to benefit societies, and to make similar personal examinations in the case of recruits, emigrants, prisoners, and candidates for employment in all public offices in which strength, activity, and health are deemed important.

The insurance offices provide the medical examiner with a printed list of questions, prepared under medical advice, or suggested by their own experience, relating to the state of health of the applicant, his family and personal history, his occupation and habits, the diseases which he has suffered, and such other particulars as are presumed to affect the probable duration of his life.

Hence the duty of the medical examiner resolves itself into a work of inquiry and a work of personal inspection and examination, respecting both of which a few practical suggestions may be offered with advantage.

1. The inquiries which the medical examiner is expected to make relate partly to the family, and partly to the personal his-

tory of the applicant. The first class are chiefly directed to ascertain the prevalence of hereditary predisposition, whether of a favourable or unfavourable character. As a general rule, the children of those who die old live to be old; while the children of parents who die young are short lived. The medical examiner should, therefore, ascertain, with respect to the parents of the applicant, if living, what age they have attained; if dead, at what age they died; and he should extend this inquiry to brothers and sisters. If the answers respecting these near relatives prove favourable, it will not be necessary to extend the inquiry further; but if they have died early, or if they appear to be subject to some hereditary malady seriously affecting the duration of life, uncles and aunts, and even a larger circle of relationship, may have to be included. Having ascertained the ages of the living and deceased members of the applicant's family, the examiner should next inquire into the causes of death* of those deceased members who have not died of old age. If one or more should be found to have died of pulmonary consumption, asthma, insanity, gout, cancer, heart disease or acute rheumatism; of some well-defined scrofulous affection; or of apoplexy or dropsy at an early age; the fact would have to be noted as more or less affecting the value of the life; and similar importance would attach to the ascertained prevalence of any of these diseases among the living members of the applicant's family.

The personal history of the applicant will comprise his age, social relation (whether married or single), occupation, place of residence, and habits of life; whether he has had small-pox, or been vaccinated, and the diseases to which he has been especially subject. Among the diseases or symptoms of disease to which the greatest importance attaches may be mentioned spitting of blood (as affording a strong probability of consumption); gout, acute rheumatism, bronchitis, and asthma (both as liable to recur and as laying a foundation for serious organic changes); dropsy (as a common result and indication of severe organic mischief); inflammation of the lungs (as leaving behind it some unfavourable change in those organs, or as being the direct consequence of tubercular deposit); fits (as betraying serious lesion of the nervous system); rupture (as involving danger of strangulation); and calculous disorder (as obviously tending to shorten life).

2. The personal examination will have to be conducted with

* A certificate of the registered cause of death of persons who have died since 1838, when the office of the Registrar-General was first established, may be obtained at Somerset House on the payment of a small fee.

greater or less care or minuteness as the family and personal history have proved favourable or otherwise. If favourable, a cursory inspection and examination will suffice: and if the applicant is well formed; the complexion healthy; the pulse regular and equal, of fair force, and not exceeding 70 or 75, or falling much below 60 (in the female not more than 80); and if the breathing is free and tranquil, the life may be safely recommended for acceptance. But if the family or personal history is unsatisfactory; if the person is ill formed or disproportioned, emaciated or bloated; if the pulse is frequent or otherwise abnormal, and the respiration unnatural; if the face is pale, the complexion unhealthy, and the expression anxious; and especially if the applicant has been attacked by any serious disease; a more minute examination directed to the state of the nervous system, of the lungs, of the heart, and of the urinary organs, will be required. The chest should be examined by percussion and auscultation, and in a few cases of disease of lung the respiration may be tested by the spirometer of Dr. Hutchinson.* In some cases the urine will have to be tested for albumen or sugar.

To these observations on the duties of the medical examiner, we add a brief summary of our knowledge of the influence on longevity, of place of residence, change of climate, occupation and habits of life, peculiarity of constitution, hereditary predispositions, and pre-existing disease.

Place of Residence.—The principal facts that have been ascertained respecting persons living within the limits of their native country are the following:—1. That the inhabitants of rural districts are longer lived than those of towns. 2. That large cities are more fatal to life than small ones. 3. That marshes, and low-lying districts on the banks of rivers, are less healthy than more elevated spots. 4. That of two districts of equal elevation, that which has a sandy or gravelly soil is healthier than that which consists of clay or rich alluvium. 5. That close, damp, and ill-drained houses are peculiarly fatal to life. Such considerations as these ought, in extreme cases, to influence the examiner in selecting lives for assurance.

Change of Climate.—The removal from a temperate or cold climate to a hot one affects the duration of life much more seriously than any change of residence from one part of a man's native country to another. Our insurance offices, accordingly, either refuse to assure lives at all in extreme cases, or demand

* For a description of this instrument, with directions for its use, tables of reference, and the indications it affords, the reader is referred to Hooper's 'Physician's Vade Mecum.'

additions to the usual premium, varying with the ascertained or estimated increase of risk. The best information we possess in reference to this subject is drawn from the reports of the mortality of our troops and seamen employed in different parts of the world; from which it appears that while the difference between low damp situations and dry elevated ones prevails everywhere, the risk to life increases with the temperature, attaining its maximum within the tropics, and falling to the standard of England, or even below it, in cold or temperate regions. Some assurance offices, acting on this general principle, allow the assured to reside without extra charge in any part of the world beyond thirty degrees from the equator, requiring from those who take up their abode within these limits an extra payment, roughly proportioned to the additional risk.

Occupation.—The occupations which shorten life are those that lead to excess in spirituous liquors; those that combine sedentary habits, or a minimum of exertion, with exposure to a close and heated atmosphere; those that entail undue exposure to the weather, with hardships and privations; those that require long hours of work, and a sacrifice of natural rest; those that are carried on in clouds of dust; and those that bring men into constant contact with poisonous substances. The employments which demand special attention, as belonging to these several heads, are licensed victuallers, potboys, and brewers' draymen; compositors, tailors, and drapers' assistants; soldiers and sailors during active warfare; bakers; knife and needle grinders; house-painters, manufacturers of cards enamelled with lead, and men who work with lead, mercury, phosphorus, or the salts of arsenic. One occupation not easily brought under any of these heads has been shown to shorten life without causing an undue amount of sickness, namely, the employment of the butcher.

The most important of the above employments, in its bearing on life assurance, is that of the licensed victualler, whose life is always regarded with suspicion, and even deemed uninsurable, in the absence of very distinct proof of temperate habits.

Habits of Life.—Luxury, sloth, dissipation, and intemperance, are very fatal to life; but the last is the only one of which it is easy to obtain distinct proof. When the fact of intemperance is clearly established it affords ground for peremptory rejection. It is also well ascertained that unusual risk attends the assuring of persons living in a continual state of pecuniary embarrassment.

Peculiarity of Constitution.—Under this head it will suffice

to notice the scrofulous constitution; the long neck and narrow chest so common in consumptive patients; and the short neck, florid complexion, large chest, and tendency to corpulency of the victims of apoplexy.

Hereditary Predisposition.—The most important disease in relation to life-assurance is pulmonary consumption; for it is in a peculiar manner the disease of grown-up men, and especially of young men, and there is no doubt that it runs in families. The inquiries of the medical examiner should, therefore, be specially directed to discover traces of this disease in the family history, and he should attach great importance to the occurrence of several deaths from this cause among the nearest relatives. Insanity, gout, asthma, urinary calculus, heart disease, dropsy, apoplexy, and cancer, especially when they appear to have caused the death of more than one member of the family at an early age, also merit serious attention.

Pre-existing Disease.—The medical examiner will have to form his own estimate of the influence which previous attacks of disease may have had on the health of the applicant and the value of his life. As a rule, mild attacks of the febrile exanthemata, which occur chiefly in childhood, and of typhus or typhoid fever in the adult, do not permanently affect the value of life. But attacks of erysipelas, gout, acute rheumatism, asthma, and consumption (which often proves fatal after several distinct attacks) must be differently viewed on account of their liability to recur. Among symptoms, that of spitting of blood, taken as an indication of consumption, is of special importance. The expectoration of a considerable quantity of vermilion-coloured blood would always warrant the rejection of a life; but even a scanty discharge of blood, whether light or dark coloured, whatever the part from which it is alleged to have come, must be regarded with suspicion, leading to a minute and careful examination of the chest. Inflammation or other severe disease of the lungs, or repeated attacks of bronchitis, figuring in the previous history of the applicant, would also lead to a careful examination of the chest; for these diseases are important in themselves, and may be the result of tubercular deposit, or lay the foundation for mortal disease of the heart.

If the applicant's family and personal history, and existing state of health, prove favourable, his life would be recommended for assurance on ordinary terms; but if unfavourable, the somewhat difficult question arises whether the life should be altogether rejected, or accepted with a greater or less addition to the ordinary premium or (what amounts to the same thing) on pay-

ment of the premium required for a healthy person of a more advanced age. Such adjustments can only be safely made by well-informed and experienced medical men. That the practical results attained under their advice are satisfactory may be inferred from the experience of the Eagle Insurance office as set forth by their actuary, Mr. George Humphreys. It appears that an average addition of 7 years for applicants whose personal or family history shows a liability to diseases of the organs of respiration, or to heart disease, has proved sufficient, and that the same addition has sufficed for persons of intemperate habits; also that an addition of 6 years has sufficed for suspicious family history and obesity, 4 for gout, and 3 for hernia. It should, however, be borne in mind that these are *average* additions, and the number of years added is greater as the applicant is younger. Thus, if we take one cause of addition with another the figures for successive decades beginning with that ending at 20, were 9, 8, 6, 5, 4, 3, and 3. As a general rule the more advanced ages demanding, as they do, a higher premium, require a smaller addition of years.

But the medical examiner may be required to give advice respecting proposals for insurance on unsound lives for short periods, and to suggest the terms on which they ought to be effected; for it may be of the utmost importance to effect an insurance for one or two years on a life which must be rejected if offered for a longer term. A young person, for instance, who has already had symptoms of pulmonary consumption, and whose chest has been ascertained to be unsound, may desire to insure his life for one year, and the examiner may have to report on the expediency of undertaking the risk; in which case he would be guided by some such considerations as the following:—Pulmonary consumption may prove fatal in any one of a long series of years, and the chances against an attack of the disease falling in any particular year are considerable; and even should it occur in the year covered by the assurance, there is the favourable chance of its commencing at a late period of the year, and either not proving fatal within the year, or (as the disease in its fatal attack has an average duration of nearly two years) not having a fatal issue till long after the period covered by the policy has run out. Similar reasonings apply to other severe diseases, and, with little modification, to the assurance of all unsound lives. On this branch of the subject, too, it is not possible to lay down any precise rules. To form a right decision large professional knowledge must be combined with sound judgment.

There are many questions bearing on the acceptance or rejec-

tion of applicants for life assurance, which can be fully discussed only in books wholly devoted to that subject,* or in such learned works as Walford's 'Insurance Cyclopædia.' But some points of practical importance may be noticed with advantage in such brief summaries as those which follow, in which some leading facts and numerical details are set forth under distinct heads.

Pulmonary Consumption.—A disease apt to be concealed under such words as asthma, bronchitis, pneumonia, frequent colds, and habitual cough; and, as a cause of death, under "death in childbed." *Fistula in ano* justifies a suspicion of it, and a small, quick, frequent pulse, spitting of blood, and unusual liability to attacks of cold, indigestion, and diarrhœa, are among its most common antecedents. It is an hereditary malady, more so in females than in males, and variously estimated as showing itself in from 25 to 60 per cent. of descendants and near relatives. The class of tubercular diseases to which it belongs, causes little less than one-seventh of all the deaths in England and Wales, of both sexes and all ages, and consumption itself nearly one-ninth. In England, females of all ages are somewhat more liable to consumption than males; but, after 15, somewhat less so, and they die earlier. In London they are less liable to consumption than males:—at all ages in the ratio of 98 to 117; above 15, in that of 163 to 213; above 20, in that of 157 to 211; and they attain their maximum mortality later.

Cancer.—Females are more liable to this disease than males in the ratio of 223 to 117; and they attain their maximum mortality earlier. The hereditary tendency to cancer has been variously estimated at from 20 to 30 per cent.

Gout.—The mortality from this disease is small in men, and still smaller in women. The hereditary tendency is estimated at 50 per cent.

Acute Rheumatism.—The liability to this disease is nearly equal in the two sexes, and the maximum mortality occurs in both in the decade ending at 25. It is not the direct cause of many deaths, but is apt to recur; and it lays the foundation of heart disease. Its hereditary tendency has been estimated at 30 per cent.

Heart Disease.—Females are somewhat more liable to heart disease than males, the increased liability showing itself chiefly after 50 years of age. Diseases of the heart (aneurism excluded) occasion about 1 in 20 of the deaths in England at all ages.

Asthma.—There are more fatal cases of asthma in men than

* Such as Brinton's 'Medical Selection of Lives for Assurance,' or Sieveking's 'Medical Adviser in Life Assurance.'

in women. It is the cause of 1 per cent. of the total deaths of males aged 35 to 45, and the maximum mortality is attained in the decade ending at 65 years of age. It is never so high as 2½ per cent.

Bronchitis.—This disease is somewhat more fatal to females than to males, and occasions 9 per cent. of the mortality at all ages. The death-rate from this disease, which is nearly 8 per cent. under 15, but only 1 per cent. in the interval from 15 to 25, increases in the following decades as the numbers 2, 5, 10, 17, and 16.

Insanity.—This is the cause of a somewhat higher mortality in women than in men; but it occasions in both sexes but a small portion (less than a half per cent.) of the total mortality. The highest proportion of deaths (0·41 in men, and 0·55 in women) occurs in the decade ending at 65. Its hereditary force has been variously estimated as 16 and 57 per cent., and it is believed to be much more decided in the higher than in the lower classes.

Nervous Disorders.—These cause a somewhat higher mortality in males than in females, and they occasion about one-eighth of the entire mortality at all ages. Apoplexy and paralysis are the special causes of most interest in reference to life assurance.

Apoplexy.—This disease is more fatal to females than to males in the proportion of about 24 to 21. The death-rate, which is about 1 per cent. for the decade ending at 25, increases, as the figures 1½, 2½, 4, 5½, and 5 in the succeeding decades, the greatest mortality being in the 10 years ending 65.

Paralysis.—The death-rate for this cause is also somewhat higher (24 to 22) in females than in males, but the excess shows itself chiefly after 60. The mortality, which is insignificant for the ten years ending 25, increases for the succeeding decades as the figures 1, 3, 3½, 5, and 7.*

On the purely legal bearings of the subject of life assurance little need be said. It is obvious that the contract entered into in a policy of insurance may be rendered void by any intentional concealment or omission of such particulars of the previous health or habits of the applicant as, if known, must have caused the life to be rejected, or accepted only on more onerous terms; also by omitting to name the medical men who have attended him in any serious illnesses. But even where there has been no fraudulent

* The figures in the foregoing statements are the ratios borne by deaths from the several diseases at the several ages to the total deaths at those ages from all causes. The figures themselves are contained in the Table at p. 144 of the 24th Annual Report of the Registrar General for the year 1871.

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FEIGNED DISEASES.

Diseases and disabilities are feigned from a great
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is discharge, and the mendicant to avoid labour, obtai
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der to excite public interest and curiosity, or private
Diseases are most apt to be feigned by those who
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to cure a real one."
... of feigned diseases a classified list will fi

distribution is into, 1. *Diseases and defects obvious to the senses*; 2. *Diseases and defects not obvious to the senses*; and, 3. *Diseases of a more complicated nature.*

I. DISEASES AND DEFECTS OBVIOUS TO THE SENSES.

This class contains the following subdivisions:—*a. Increased and diminished size of parts. b. Malformations. c. Wounds, ulcers, and superficial inflammations. d. Discharges. e. Spasmodic affections. f. Paralytic affections.*

a. Increased and diminished Size of Parts.—Tumours. A favourite mode of producing tumours is by injecting air into the cellular tissue—beneath the skin of the abdomen to imitate *ascites*, into the scrotum to imitate *hydrocele* and *hernia*, under the scalp to give the appearance of *hydrocephalus*, into various parts of the limbs, with the help of ligatures, to imitate local swellings. The aperture through which the air has been introduced is usually found covered by a small piece of plaster. Tumours are also produced by pressure. Swellings of the limbs, *anasarca*, *varicose veins*, and an appearance resembling *elephantiasis*, have been caused by ligatures; and *œdema* of the arm by hanging the limb over the back of a chair. Marks of the pressure are discoverable on careful search. *Tympanites* has been imitated by swallowing air, or drinking quantities of chalk and vinegar. A solution of Glauber's salts in weak tobacco-water proved very efficacious in the hands of Dr. O'Hara. Abdominal tumours have been imitated by forcible protrusion of the spine. Local diseases of this class have been simulated by extraneous substances:—*polypus of the nose*, by the testes of a cock, or the kidneys of a rabbit, retained in the nostril, perhaps impregnated with fœtid juices. Strong sternutatories unmask these cases. *Hæmorrhoids* have been imitated by the bladders of rats or small fish partly introduced into the rectum. *Prolapsus ani* by the gut of an ox or sheep, or by the everted anal extremity of the bowel of a colt or hog. In one case mentioned by Percy and Laurent, prolapsus was actually produced by passing into the bowel the bladder of a sheep, distending it with air, and forcibly retracting it. *Prolapsus uteri* has been imitated by similar means; *hydatids* of the womb by vesicles prepared from the intestines of a pig; *malignant tumours* by a sponge soaked in various colouring matters; and *hernia* by the injection of air, or the forcible retraction of the testicles towards the rings. *Cancer* has been imitated by a cow's spleen, and by a sponge moistened with milk fixed under the armpit. *Swellings of the joints*, intended to represent white swellings, have been produced by acrid plants,

such as the ranunculus acris or sceleratus, applied to the part. Enlargement of the abdomen in the female has been simulated by a pad. *Partial atrophy* may be produced by pressure.

The frauds comprised under this head require, for their detection, a careful examination of the part by the eye and by the touch.

b. Malformations.—Lateral curvature of the spine has been imitated. The curve is in the dorso-lumbar region, and single: the convex side not gibbous. The skin on the concave side is folded once or twice; and the haunch of that side is so raised as to give the leg the appearance of being shortened. *Gibbosity*, or *elevation of the shoulders*, *wry neck*, *hip disease*, and *contractions of the limbs or joints*, are imitated by long-continued flexion, aided by inaction and the use of tight bandages. The contraction is usually attributed to a previous attack of rheumatism; but sometimes to a burn or previous injury. In these cases suspicion is excited by the hard-swollen state of the contracted muscles; and the absence of cicatrix, and of atrophy of the limb. The means proposed for the detection of these impositions are:—pressure on the nerves supplying the contracted muscles; application of a wet bandage tightly round the limb, which, when dry, may compress the muscles; moving the limb during natural sleep; examining the limb during the sickness and weakness produced by an emetic, or by intoxication, or, better still, under the influence of chloroform; the electric shock; gradual and repeated tension by a pulley or weights; making sudden extension while the attention is engaged; the actual cautery, if that remedy be indicated in the real disease; or recommending the warm climate of the coast of Africa as a cure. In some cases the most effectual method is to treat the deformity as a matter of no importance, not requiring surgical treatment. *Dislocations*, especially of the shoulder-joint and patella, may be produced intentionally, and real *fractures* are converted into false joints by frequent motion.

c. Wounds, Ulcers, and Superficial Inflammations.—Mutilation is a common practice in the army, especially in regiments submitted to very strict and harassing duties; and in countries where the conscription is in force. Convicts at public works are also addicted to placing their hands under the wheels of waggons. *Wounds.*—The distinction between wounds self-inflicted, inflicted by others, or accidental, will be considered under the head of wounds. *Bruises* have been imitated by colouring materials, but not being true to nature, are easily detected by the expe-

rienced eye. *Ulcers*, when they exist naturally, are often intentionally increased; or they are caused by the application of corrosive acids and alkalies, caustics, corrosive sublimate, arsenic, and its sulphuret, copper wire, acetate of copper, blistering plaster, quicklime, the flame of burning bodies, the ashes and chewed leaves of tobacco, such vegetable acrids as ranunculus acris and sceleratus, mezereon, euphorbium, arum maculatum, and juniper; and by pressure or friction with sand. Ulcers have also been imitated by a portion of a spleen or the skin of a frog kept moist with blood and water. The legs are the parts usually chosen for these tricks. Factitious ulcers may be detected by careful inspection of the surface and dressings, or close examination with the lens. The sudden and repeated increase of inflammation round the part, and the healthy appearance of the sufferer, naturally excite suspicion. In hospitals and prisons the leg may be enclosed in a box. *Fistula in ano* and *in perineo* have been imitated by inserting a tent dipped in some irritant, or made of the root of the milk thistle, or white hellebore, into a puncture. Factitious *skin diseases* have been produced:—*lupus* by pounded garlic, or the juice of the euphorbium; *erysipelas*, by blisters; *urticaria*, by eating shell-fish; *psoriasis* and *impetigo*, by strong rubefacients; *pompholyx*, by blistering plaster; *scabies*, by punctures irritated with gunpowder; *porrigo*, by nitric acid dropped on the hand, or by a paste composed of rancid butter, honey, sulphur, and powder of cantharides. *Baldness* has been effected by nitric acid. *Variola* in its eruptive stage has been imitated by bay-salt and gunpowder rubbed into punctures. *Jaundice* has been imitated by several colouring matters.

Factitious diseases of the eyes are not uncommon. *Ophthalmia* has been excited by gonorrhœal matter, nitric acid, corrosive sublimate, sulphate of copper, nitrate of silver, lime, pepper, snuff, the smoke and juice of tobacco, salt, alum, the powdered root of euphorbium, a blast of cold air, cantharides, friction, particles of sand, and fragments of cloth or muslin. The counterfeit disease is generally confined to the conjunctiva of one eye, and that the right; its progress is rapid, and it stops short of affecting the vision. Among soldiers it attacks only the privates and non-commissioned officers. The irritants that have been used may often be detected, as in the case of ulcers, by simple inspection. *Ophthalmia tarsi* is simulated by strong irritants, or the extraction of the eyelashes. A healthy aspect of countenance would excite suspicion, as the real disease rarely occurs but in the scrofulous and cachectic. *Opacity of the cornea* has been caused by dropping

a strong acid into the eye, or introducing a fragment of lime or other irritant; and *Cataract* by passing a fine needle through the cornea to the lens.

d. Discharges.—Vomiting is effected by pressure on the pit of the stomach, by swallowing air, by a sudden strong action of the abdominal muscles assisted by tickling the fauces, as well as by emetics. The matters vomited consist of water, urine, and even fæces, and the larvæ of insects. Factitious vomiting is generally unattended by emaciation, and the other concomitants of the diseases of which it is a symptom. *Diarrhœa* and *dysentery*, too, are both feigned and excited; feigned, by mixing an ordinary evacuation with urine; excited, by a mixture of vinegar and burnt cork, by a solution of soap or sulphate of iron, by drastic purges, or by irritating substances passed into the rectum. The motions are sometimes tinged with blood procured by puncture, laceration, or strong suction of the gums; or they are coloured dark red by logwood, green by senna, and black by deep-coloured wines. The fraud is discovered by careful examination of the evacuations, the use of a separate close-stool, the inspection of the linen, and the absence of the associated symptoms of the real disease. *Ascarides* have been clumsily imitated by pieces of thread. A species of lizard was placed in the evacuations, in a case related by Dr. Spence. *Urinary deposits* have been found to consist of sand, pebbles, and pieces of quartz and flint. Fragments of brick, slate, bone, or cinder, and small pebbles, have been introduced into the urethra, or vagina, to bear out the alleged existence of urinary calculus. Mere inspection, assisted, in some cases, by chemical tests, will unmask such impositions. *Hæmaturia* has been simulated by the use of beet-root, madder, cochineal, the Indian fig, the fruit of the prickly pear, and logwood; and caused by savin, cantharides, and turpentine. Blood has also been injected into the bladder, or mixed with the discharged urine; or it has been obtained from the urethra by scratches. Different colours have been imparted to the urine by such substances as madder, logwood, indigo, rhubarb, black cherries, the whortleberry, the pulp of cassia fistula, elder rob, and ferrocyanate of potass, or of iron, taken internally. Milk has been added to the urine to give it a white colour. In suspicious cases, the medical man should cause urine to be passed in his presence. The absence of the local and constitutional symptoms proper to affections of the kidney and bladder will assist the diagnosis. *Gonorrhœa* has been imitated by the use of caustics; the *menstrual discharge* by staining the linen with Bullock's blood; and *epistaxis* has been produced by incisions.

Hæmoptysis, a favourite factitious disease, is imitated by a bloody sponge held in the mouth, by incisions in the mouth, gums, or back of the throat, or by blood sucked from other parts of the body; also by pastilles coloured with carmine, Armenian bole, brickdust, or vermilion. The mouth having been carefully examined, and rinsed with water, the rejected fluid should be inspected, and, if necessary, analysed. *Hæmatemesis* is simulated by swallowing the blood of an animal. *Otorrhœa*, has been simulated by honey, pus, rancid tallow, assafœtida, or old cheese, placed in the meatus, and excited by cantharides, or by irritating liquids; and *Ozæna* by similar means. *Fœtid breath and perspiration* have been produced by oil of dipple, assafœtida, old cheese, putrefying fish, and the rancid oil from a cart wheel. Ablutions, emetics, and close watching, will serve to detect these impositions.

e. Spasmodic affections.—These are frequently and successfully feigned, especially *Epilepsy*, which has the recommendation of being assumed at convenient times. In addition to the violent struggles which characterize the true disease, impostors inflict bruises on their persons as evidence of former attacks, vomit blood previously swallowed, imitate the foam at the mouth by chewing soap, and discharge the urine as if involuntarily. As in the true epileptic seizure there is an entire absence of sensibility, the feigned disease is readily detected by the use of some powerful stimulant, such as hartshorn, burning sulphur, snuff, or pepper, applied to the nostril; a few drops of alcohol or turpentine poured into the eye; a solution of mustard, or common salt, placed in the mouth; hot water, or actual flame applied to the skin. The flecking of the naked feet with a wet towel or handkerchief is an unobjectionable and highly effectual test. Some impostors resist such tests as pricking their skin. *Convulsions.*—These are sometimes the effect of involuntary imitation, sometimes they are solitary impositions, more frequent in women than in men. The chief difference between real and feigned convulsions is, that the one occasions little exhaustion, the other much. To discover the fraud "it is sufficient to act with force on the antagonist muscles." (Orfila.) Impostors often select muscles which are rarely affected by real convulsions, such as those of the abdomen or shoulders. *Chorea.*—This, like other convulsive disorders, has been the offspring of fanaticism, of imitation, and of voluntary deception. When skilfully feigned, the diagnosis is not easy. Cold affusions and electricity, which may be used with propriety in true chorea, are not pleasant

remedies for impostors. *Hysteria.*—It is of little consequence whether an attack of hysteria be feigned or not: cold affusion, which is the best remedy for the real disease, is not a pleasant application in feigned attacks. *Catalepsy*, is very rare, and its existence, especially in a male, justifies suspicion. Powerful stimulants, the proposal of the actual cautery while the finger is on the pulse, appending a weight to the extended limb and cutting the string suddenly, have been recommended and practised with effect in feigned cases. Unsuccessful attempts have been made to feign *tetanus* and *hydrophobia*. The fingers have been forcibly contracted, and the nails driven into the palm of the hand. By wearying the muscles with a conical piece of wood this imposition is readily detected. *Stammering* is often feigned. The best distinction is founded on the fact, that true stammerers hesitate little or not at all in repeating what they know by heart, and in singing. *Strabismus, nictitation*, and *blepharospasmus* are unimportant and easily pretended. *Dysphagia*, when feigned, may be cured by the persevering use of the probang. The suspected person should be narrowly watched. *Stricture of the urethra* has been feigned, but as the treatment of the real disease is not agreeable, the imposition is soon abandoned.

f. Paralytic Affections (*Hemiplegia, Paraplegia*, and *Local Paralysis*).—In true palsy, the affected parts are relaxed and emaciated, and their temperature is lowered. In paraplegia, the urine generally undergoes a marked change. These characters are not present in the fictitious malady. Every form of partial paralysis has been feigned. In palsy of the fore-arm and hand, the discovery of a blue line on the gums would be a reason for believing the paralysis real. *Paralysis agitans.*—It is characteristic of the real disease that the patient in attempting to walk "is impelled unwillingly to adopt a running pace." But the pretender hesitates in his movements and advances with difficulty. It happens fortunately that the remedies proper for real palsy are not agreeable ones; and where there is a good ground for suspicion, low diet will be found a useful auxiliary. *Ptosis.*—The impostor generally makes attempts to prevent the raising of the eyelid, and thus betrays himself. *Feigned insensibility* may be detected by stimulants, and often by inconsistent statements as to the cause. *Coma* and *lethargy* have been successfully feigned, and in one or two instances the impostor has resisted every stimulant that could be thought of. In one case the operation of trephining caused merely a single groan. The treatment which we should be justified in resorting to if the complaint were real proves a trying discipline to most impostors. *Syncope.*

This scarcely admits of being feigned, for if the impostor can contrive to grow pale, he cannot control the action of the heart and arteries. More than one case, however, of a voluntary control over the circulation is on record, for which the reader is referred to the chapter on Real and Apparent Death. Cases of feigned and imputed poisoning will be noticed under the head of *Poisons*. Cases of fraudulent disposal of a dead body so as that death may appear to have been due to hanging or drowning will be found under those headings. Among prisoners unreal attempts at suicide by suspension or strangulation are usually made when assistance is known to be at hand. The feigned insensibility which follows is best unmasked by the electric shock.

II. DISEASES AND DEFECTS NOT OBVIOUS TO THE SENSES.

To this head belong, *a, increased,* and *b, diminished sensation.*

a. Increased sensation.—Pain. This is easy to assume and difficult to detect. Severe neuralgia often occurs in persons otherwise, to all appearance, healthy; and the cause of many acute pains is extremely obscure, so that real suffering has been treated as if it were assumed. In dealing with cases of this class great caution and patience are necessary; for some malingerers have submitted to the most severe and trying remedies, and even to the removal of the breasts and limbs, for simulated neuralgic affections. *Pain in the head,* and the giddiness which often accompanies it, are also easily feigned, and not easily proved to be so, and the same is true of *rheumatic pains* in every part of the body, especially in the loins and thighs, inasmuch as they are not accompanied by any change in the parts affected, or by any well-marked constitutional symptoms. In many works on feigned diseases, long rules are given for detecting feigned pain, and the symptoms of almost every disease accompanied by pain are minutely detailed; but it may be stated as a general rule that the more obscure feigned diseases can be detected only by those who have extensive experience of real ones.

b. Diminished sensation.—Amaurosis is a favourite feigned disease, produced by the juice or extract of belladonna or hyoscyamus, the distilled water of the spurge-laurel, or snuff moistened with a decoction of belladonna. It disappears if the impostor be carefully isolated and watched. In illustration of the perseverance with which the pretence of blindness is sometimes carried out, a case is related by Mahon. A recruit feigned blindness, and, after all other means had been tried without success, he was placed on the bank of a river, and ordered to walk for-

ward, which he did. He afterwards confessed the imposture. *Myopia.*—Short-sightedness being a disability in the army is often feigned. It may be detected by placing an open book close to the face, or by requiring the suspected person to read print at some distance by the aid of glasses for the near-sighted. *Presbyopia* is rarely feigned. The mode of detection is the converse of the preceding. *Amblyopia*, or weak sight, is also rarely pretended. *Nyctalopia.*—Night-blindness. This disease is peculiar to warm climates, in which the sun's rays have great power. There are no satisfactory means of distinguishing the true from the feigned disease, as opposite states of pupil may exist in different cases. *Hemeralopia*, or day-blindness, is not important. It is an occasional symptom of worms, or of other intestinal irritation. The diagnosis will depend upon our knowledge of the disease of which it is a symptom. In the army these pretended defects are best cured by employing the subjects of them in distasteful services for which the real defect does not unfit them. *Deafness.*—As this may occur without change in the external ear, it is a favourite imposition. A watch should be set on the suspected person day and night; and it has been recommended to place the fingers on the pulse while bad news, or a threat of punishment, is being uttered; to call him sharply or unexpectedly by name, or in a whisper; to rouse him from sleep and then speak to him, or to let a piece of money fall close to him. All such tests, and even the loudest noises, have failed. In one case, related by Dunlop, a pistol was fired off close to the ear without effect; but on the man being sent to sleep by opium, the imposition was detected on the repetition of the firing. *Dumbness.*—This is sometimes assumed with great perseverance. As a general rule if a man not deaf can move his tongue he is not dumb. Some add to pretended dumbness a feigned mutilation of the tongue, which they effect by rolling it back into the throat, and scratching it to make it bleed. A beggar who had excited great commiseration by a written paper describing his captivity among the Algerines, and his mutilation by them, was unmasked by a surgeon, who, pretending to give entire credence to the man's tale, and taking a half-crown out of his pocket, requested him to show him his tongue once more, upon which he thrust his finger suddenly against the root, and the tongue rolled out. *Deaf-dumbness.*—The combination of deafness and dumbness, though never occurring in a person previously in possession of hearing and speech, is sometimes obstinately pretended. Some impostors, after resisting every test, have been detected by those having personal experience of the really deaf and dumb.

III. DISEASES OF A MORE COMPLICATED KIND.

In the previous divisions those impositions have been considered which consist of a single outward manifestation, tangible or visible; or of a single alleged symptom or defect, not combined with other symptoms to constitute a disease. It now remains to speak of cases in which whole trains of symptoms proper to certain diseases have been assumed, with more or less success. This division consists of two classes: *a. Diseases of the body. b. Diseases of the mind.*

a. Diseases of the Body.—Fever. Foderé states, that he has often seen impostors produce an extraordinary frequency of pulse, accompanied with chattering of the teeth and profound sighs. Febrile symptoms may be excited by strong stimulants, such as wine, brandy, or cantharides; also by the introduction of a clove of garlic into the rectum. Violent exercise, or strong contraction of the limbs, or a heap of blankets has been resorted to as a means of imitating fever, the tongue being whitened by chalk, pipeclay, soap, flour, or whiting; and tinged brown by tobacco, brick-dust, liquorice, or gingerbread. Pallor of the skin has been imitated by emetics, by smoking, by digitalis, or by drinking an infusion of cumin seeds; and a flush by friction. The detection of cases of simulated fever is easy. The effects are always ephemeral, and all that is needed is to watch the patient for a few hours. *Ague* is often feigned, but not with much success. The shivering fit is not followed by the other stages. The effort to imitate the rigors throws the impostor into a perspiration, which leads to detection. Various *chest* affections are assumed. *Pneumonia.*—In one instance mentioned by Dr. Gavin this was assumed, but unsuccessfully. The stethoscope serves to prove its non-existence. *Phthisis.*—It is difficult to deceive a careful observer, skilled in the use of the stethoscope; but many symptoms of the disease have been successfully assumed. Hæmoptysis and mucous expectoration have been imitated in the manner already described. Emaciation may be produced by abstinence, by drinking vinegar, or by sucking a copper coin; febrile symptoms by the means just pointed out. *Asthma*, also, has been imitated, but the stethoscope assists in the detection. *Apoplexy* cannot be successfully feigned. The fraud is easily detected by sternutatories, or by strong stimulants. *Dyspepsia.*—Vomiting, gastralgia, pyrosis, and in fact all the symptoms of dyspepsia have been assumed, and the imposition has been detected only by careful watching. *Gastritis*, or acute dyspepsia.—The constant vomiting and bright-red tongue of acute gastritis

are not easily assumed. *Peritonitis.*—In one case in which there was a pretence of great pain increased by pressure, a dose of opium was given, and the man bore very strong pressure without being roused from sleep. *Hepatitis* in its chronic form is a favourite feigned disease, as it is very prevalent in hot climates, and is supposed to be common in this country. The dull heavy pain in the right side, and the pain in the shoulder are easily assumed, but the discoloured eye and skin, the unhealthy aspect of the countenance, and the mental depression and listlessness less readily. *Jaundice* has been imitated by staining the skin with an infusion of the root of curcuma longa, or of saffron, with tincture of rhubarb, the bruised seeds of the broom, or the stamens of the iris. Clay-coloured stools have been produced by taking small quantities of muriatic acid, the colour of the urine has been heightened by rhubarb, and attempts have been made to pass off pebbles for gall-stones; but it is not easy to tinge the conjunctiva yellow, nor to combine the yellow skin, pale stools, and high-coloured urine. *Scurvy.*—One prominent symptom of this affection, the spongy and bleeding gums, is often imitated by the use of irritating substances or by puncturing the gums previous to the visit. The other symptoms are not easily feigned. *Nephritis.*—The pain of this disease has been assumed, and confirmed by producing pebbles or fragments of brick; but it is not easy to assume all the symptoms of nephritis.

This division of feigned diseases might be treated at great length, and minute rules for diagnosis be laid down; but it is not by written description, but by actual experience of diseases, that the true are to be distinguished from the false. In doubtful cases, reference must be made to the best description of the disease supposed to be assumed, with the understanding that symptoms commonly deemed of high diagnostic value may be absent in the real affection, and so lead to unjust suspicions. Those who are familiar with treatises on this subject will know how much of false diagnosis they contain.

b. Diseases of the Mind.—Feigned insanity will be treated in the next chapter under Unsoundness of Mind.

The following general rules may render some assistance in distinguishing a feigned disease from a real one.

RULES FOR THE DETECTION OF FEIGNED AND FACTITIOUS DISEASES.

1. Inquire into the existence of motives for deception. Will the suspected person, by imposition, gain anything he desires, or escape anything he dreads? It should, however, be borne in

mind that both men and women feign diseases from other motives than those of gain; and that there may be so complete an absence of all discoverable motives, as to force us to believe in the existence of a moral insanity displaying itself in this way.

2. Inquire into the previous history of the patient, and the character he bears among his comrades or companions; and whether he has been previously noted for dishonesty and deception. But men who have for years borne the best characters, and conducted themselves with propriety, have been convicted of malingering.

3. When the assumed disease is external and obvious to the senses, make a minute and careful examination both by eye and hand. When there is a suspicion of the use of some irritating substance, inspect the part narrowly with the lens, search the pockets, boxes, or bed of the suspected party, and, if necessary, isolate him so as to deprive him of the assistance of others, and of his means of deception. Examine substances alleged to have been discharged, if necessary by the microscope or by chemical tests. In cases of rigidity, anchylosis, or deformity, place the suspected person under the influence of chloroform.

4. When some defect, or disability not obvious to the senses, but depending on the assertion of the person himself, as pain, deafness, &c., is supposed to be assumed, try to take him by surprise. Assumed deafness, for instance, should be tested by sudden noises, speaking sharply to the suspected person on his being roused from sleep, or when his self-control has been impaired by opium or chloroform.

5. In cases of feigned diseases, properly so called, we must inquire minutely into the history and alleged causes, and compare the symptoms present with good descriptions of the real disease.

6. The suspected person should be visited at times when he does not expect to be seen; be watched by those whom he is not likely to suspect; and be misled into the assumption of symptoms foreign to the malady he is simulating. By concealing his suspicions, and foretelling the advent of symptoms which do not belong to the assumed disease, the medical man may lead the malingerer to betray himself.

7. Ascertain whether the suspected person makes use of the medicines and measures prescribed for his relief.

8. In the treatment of suspicious cases, no measures ought to be employed which would not be justifiable if the disease were real. But when there is strong ground for suspicion, low diet, isolation, and nauseous medicines may be resorted to. When the disease supposed to be assumed is not dangerous (*e. g.*, spasmodic

twitchings of the muscles), it should be treated with indifference, and as not requiring medical treatment. Persons wantonly abstaining from food generally desist if allusion is made, in their hearing, to cases of prolonged abstinence; and refusal to take exercise may be met by striking off the best meal of the day, as unnecessary in such cases. Impostors may be caused to desist by treating their several symptoms in detail. A convict professed excruciating headache, offensive discharge from the ear, palsy of an arm, and weakness of the legs. The pain in the head was met by the quiet of a solitary cell; a fragment of blotting paper was placed in the ear, which was covered with adhesive plaster, so that the nature of the discharge might be ascertained. The dropped hand was supported by a splint, and the extensor muscles strengthened by sharp electric shocks. His diet was proportioned to the exercise he could contrive to take. Under this treatment he improved daily. There was no offensive discharge from the ear. In three weeks he was strong enough to attempt an escape from prison, in which attempt he displayed great strength and activity.

Closely connected with this subject is that of disqualifying diseases. It is chiefly interesting to military and naval surgeons; but the services of the medical man are occasionally required in civil cases. He may be directed to ascertain whether a person is fit to serve on a jury, or to attend as a witness; whether he is competent to take on him certain offices or duties; or can bear hard labour, or other severe punishment. He may also have to ascertain the state of health of children presenting themselves for admission into public schools. In this case, as in that of recruits, and of persons desirous of insuring their lives, attempts are made to represent the health as better than it really is, and to conceal defects and diseases actually existing. The subject of disqualification in civil and criminal cases scarcely requires, or admits of, any precise rules; and disqualification for military service is treated in works which the military surgeon is required to possess. The foregoing observations on feigned and fictitious maladies apply to *malingerers* in the army and *skulkers* in the navy no less than to impostors in civil life.

CHAPTER V.

UNSOUNDNESS OF MIND.

a subject on which medical men are often required to
ence. A man makes a will; its validity is disputed:
testator, when he made it, in full possession of his
Another squanders his property, or is accused of so
he competent to manage his affairs? A third con-
unsuitable marriage: could he give a valid consent to
act? A criminal, or person under accusation, makes a
: was his mind sound when he made it? An act of
ocity is committed: was the perpetrator responsible for
A criminal is supposed to feign insanity that he may
nishment: is he really of unsound mind? That these
are of frequent occurrence may be inferred from the
there are upwards of 50,000 persons of recognised
mind in England; that the number of certified cases
for many years increasing at the rate of 1000 a year;
the number of insane persons of all classes and ages cer-
eeds the full estimated proportion for Europe generally
0 of the population.

edical man may be summoned to give his evidence in
r courts of law, civil, criminal, or ecclesiastical: before
ns technically designated *de lunatico inquirendo;* in
of criminals brought up for trial; and, in the case of
natics, before a magistrate. He may also be called
ign certificates of unsoundness, at the instance of private
with a view to provide for the safe custody and proper
t of those in whom they are interested.

quiries into the state of the mind are surrounded by
difficulties—difficulties inherent in the subject itself, or
y the requirements of the law, and public feeling and
. The difficulties of the first order arise out of the
individual character of the mind, the degree in which it
e been developed by instruction and education, and the
and restraint to which it may have been subjected.

Other difficulties inherent in the subject are to be found in the purely inferential character of our knowledge of the mind, in the inapplicability to it of the method of experiment, in the want of any recognised standard of sanity, and in the necessity of erecting our own mental experience into a standard for the minds of others. Minds thus differing in original power, and in acquired knowledge and habits, are variously affected by the same physical and moral causes, and subject to many distinct forms of disease, displaying themselves in language and acts the most varied. Some part of the difficulty that surrounds this subject is also to be traced to the undue importance formerly given, in metaphysical treatises, to the higher faculties of the mind. Reason and imagination were put so prominently forward, and the emotions and passions made to play so subordinate a part, that soundness and unsoundness of mind came to be regarded as almost synonymous with a sound or erring reason; imagination had to bear all the blame of misleading the judgment; and delusion became the favourite and sole test of insanity.

A more simple and practical theory of the mind, recognising several distinct faculties, has now taken the place of the narrow speculations of the older metaphysicians. And this theory of separate faculties, originally of different power in different persons, more or less improved by instruction and education, under greater or less restraint from without or within, subject to different degrees of excitement from causes acting within the body or external to it, is the theory that agrees best with reason and experience, offers the readiest explanation of the infinite variety of character, the endless diversities of opinion, and the strange eccentricities of conduct prevailing among mankind, and is most in harmony with what we know of the unsound mind.

The second class of difficulties, or those due to legal requirements, originate in part from the lawyer's inexperience of the unsound mind, the narrow views handed down to him, and the selection of tests difficult, if not impossible, of application: also in part from his looking at the whole question, mainly as it affects individual liberty, or the safety of the State.

The difficulties of the third class, or those that arise out of the state of public feeling, are partly political and partly religious—political, inasmuch as the views expressed with respect to persons of unsound mind are regarded, not as they are true or false, but as they are thought to affect the safety and well-being of society; religious, because being deeply impressed with the fallen and sinful nature of man, the most estimable persons are ever ready

to trace strange thoughts and revolting acts rather to that original taint than to disease.

In treating of the unsound mind, we must premise that it is not possible to frame a single definition of that state, nor to present a just view of it in one description; for mental unsoundness assumes many shapes, necessitating many divisions and subdivisions, with a corresponding nomenclature. In framing a fitting classification and nomenclature, we shall adopt, as far as practicable, the divisions and names sanctioned by legal usage. Where the law defines with precision the meaning of terms, those terms will be preferred; but where it has failed to do so, those will be employed which have been accepted by the best medical authorities.

In the search after appropriate terms, we first encounter the words "mad" and "insane," applied to the person affected; "madness" and "insanity," to the state of the sufferer. These terms might be at once adopted if they were commonly used as the exact opposites of the words "sane" and "sanity." But as they are generally employed in a restricted sense, and apply chiefly to such deviations from the healthy state of the mind as consist in excessive activity, and rarely, if ever, to those characterized by deficient energy, original or acquired, we must seek for terms to which we may attach a more precise meaning. Such are "Unsoundness of mind" applied to the condition of the mind itself, and "Non compos mentis" to the person whose mind is affected.

But of these terms, the first—"Unsoundness of mind" is not free from objection; for in the Portsmouth case Lord Eldon spoke of it as a state requiring to be distinguished, both from idiocy and lunacy, and in many statutes it is found associated with the words Idiot and Lunatic. Still, as it is better than "Insanity," or any other phrase in common use, it is placed at the head of this chapter. The other term, "Non compos mentis," applied to persons of unsound mind, has been more consistently used by legal authorities, and is therefore to be preferred to all others.

Having thus chosen a term comprehensive enough to include all deviations from a state of sanity, we must next inquire what the law includes under this term, *non compos mentis*, what forms of unsoundness it recognises, and how far it consists with our knowledge as medical men to adopt a subdivision in accordance with it.

The common law of England originally included under this term only two forms, Idiocy and Lunacy, but the highest legal authorities have seen the necessity of more minute subdivision.

Thus Lord Coke recognised four sorts of *non compos mentis*.—"1. *Idiota*, which from his nativity by a perpetual infirmity is *non compos mentis*. 2. He that by sickness, grief, or other accident wholly loseth his memory and understanding. 3. A lunatic that hath sometime his understanding, and sometimes not, *aliquando gaudet lucidis intervallis*, and therefore he is called *non compos mentis* so long as he hath not understanding. Lastly, he that by his own vicious act for a time depriveth himself of his memory and understanding, as he that is drunken."

Here we have distinctly recognised three forms of unsoundness, *Idiocy*, *Dementia*, and *Lunacy*; of which the first two are so well defined as to admit of being used both by lawyers and doctors in the work of classification. But the term *Lunacy* is objectionable, as implying only that form of mania which is characterized by lucid intervals.

Since Lord Coke's time little has been done towards a better classification; though Lord Hale, in recognising a distinction between general, or total, and partial unsoundness, may be said to justify the separation of monomania from mania. If this be so, we have good legal authority for at least four forms of unsoundness—Idiocy, Dementia, Mania, and Monomania.

These four states, taken as varieties recognised by the law, may be expanded into a reasonable and useful classification by adding the forms or phases of unsoundness recognised by the best medical authorities. Idiocy, Imbecility, and Cretinism, may be made to fall under the one heading, *Amentia*; *Dementia* to comprise the acute and chronic, or primary and secondary, forms of mental degeneracy, as well as the state known as General Paralysis; and *Mania*, not affections of the intellect only, but those also of the emotions, recognising in both a general and a partial unsoundness. The following tabular arrangement presents the leading forms of unsoundness at one view:—

UNSOUNDNESS OF MIND.

Amentia.	*Dementia.*	*Mania.*		
1. Idiocy.	1. Acute, or primary.	1. General (*Raving Incoherence*).		
2. Imbecility	2. Chronic, or secondary.	2. Intellectual	General.	
3. Cretinism.	3. Senile Dementia.		Partial.	Monomania. Melancholia.
	4. General Paralysis of the Insane.	3. Moral . .	General	
			Partial.	Homicidal. Suicidal. &c. &c

This classification, be it understood, is not put forward as a

condensed philosophy of the unsound mind, but rather as a convenient index of the order in which this subject will be treated. Cretinism, for instance, is a condition which comprises both Idiocy and Imbecility, but with corporeal defects and malformations so peculiar as to require separate notice; in like manner, Senile Dementia and the General Paralysis of the Insane, though alike involving mental decay, demand a separate recognition; while the many forms of Mania are but imperfectly set forth in the table. Perhaps the most philosophical classification that could be proposed would be based on the recognition of three leading forms:—the *undeveloped*, the *degenerate*, and the *disordered* mind—Amentia, Dementia, and Mania.

As unsoundness of mind is a large subject, embracing many details, a methodical arrangement of it is absolutely necessary. It will accordingly be treated under the following heads:—1. Of certain states of mind compatible with sanity, but illustrative of unsoundness—viz., illusions, dreams, and somnambulism. 2. Of certain states allied to unsoundness, and caused by disease, or the action of poisons—viz., delirium, delirium tremens, and drunkenness. 3. Of the several forms of unsound mind treated in the order in which they stand in the foregoing table. 4. Of the more important characters of the unsound mind, and of its medical and legal tests. 5. Of feigned unsoundness of mind. 6. Rules for the examination of persons deemed to be of unsound mind, and for the guidance of the medical witness in these cases.

I. ILLUSIONS, DREAMS, AND SOMNAMBULISM.

These phenomena have a close connexion with, and direct bearing on, mental unsoundness. Spectral and other illusions are common in the insane; dreams are generally recognised as analogues of insanity, and the acts of the somnambulist may give rise to medico-legal questions.

Illusions.—A sensation without a corresponding external object is called an *illusion*. When it is due to an act of the will, it is known as a *vivid perception*. When the eye is, or seems to be, the seat of the sensation, it is called a *spectral illusion*, *phantom*, or *phantasm*. In the well-known case of Buranelli, the medical witnesses were examined as to the proper meaning of the words *illusion* and *delusion*. There ought to have been no difficulty in defining them. The difference is best shown by adding three words to each:—an illusion of the senses, a delusion of the mind. An illusion means a mockery, false show, or counterfeit appearance; a delusion, a chimerical thought. It may be well to add that an illusion of the senses, if believed to be a

reality, becomes a delusion of the mind. The word illusion may be applied, with equal propriety, to a sensation without corresponding object, to a transformed appearance of a real object, or to an internal sensation exaggerated or misinterpreted. It is improperly applied to real sensations, as of enlarged shadows projected on to masses of clouds, misinterpreted for a time through ignorance and superstition into the "Giant of the Brocken," sailing ships, and fighting armies. Those who wish to distinguish illusions, pure and simple, from what may be called "illusive transformations," make use of the term *hallucination*. Brierre de Boismont, for instance, uses the term to designate an unreal sensation wholly due to the action of the brain; and *illusion* to designate a real sensation exaggerated or distorted by the same operation; and Griesinger, quoting Esquirol with approval, sanctions substantially the same distinction. This word, as the French use it, has indeed the same meaning as our word illusion, but as old English writers used it in the sense of an error, mistake, or blunder, and medical writers sometimes of an illusion, sometimes of a delusion, it ought to be allowed to fall into disuse. Whatever terms, however, we elect to use—these four distinct conditions—we ought not to confound the one with the other; a voluntary representation of an idea on an organ of sense, which is a vivid conception; a sensation, without corresponding external object, which is an illusion; an involuntary transformation of a real object, which is also an illusion; and an actual vision (*e.g.*, a mirage) simply misunderstood and misinterpreted.

Illusions may occur as early as four years of age; in young and middle-aged adults; and in octogenarians: some in perfect health, some suffering from trivial and transient indispositions curable by such remedies as moderate depletion and simple aperients, others in the first onset of more serious diseases, inflammatory and febrile, or during convalescence. Illusions have also been produced by every form of arrested and disordered circulation through the brain, by the inhalation of carbonic acid, or its generation within the body itself, and by many poisons of the narcotic and narcotico-acrid class; and notably by opium, alcohol, Indian hemp, belladonna, hyoscyamus, and stramonium. Illusions of sight (spectral illusions) are the most common; those of hearing come next in order; those of taste, smell, and touch, are more rare. In spectral illusions, which have been most studied, there are differences interesting to physiology, but of little practical importance.*

* For cases in detail see Hibbert on 'Apparitions,' Sir David Brewster's 'Letters on Natural Magic,' Sir Walter Scott's 'Demonology and Witchcraft,' and Brierre de Boismont 'On Hallucinations.'

But these two facts may be applied with advantage in the study of the unsound mind;—1. That these illusions occur in the irremediably blind, and that, in these cases, they must result from changes in the cerebral circulation, or of the brain-tissue. 2. That though, in some cases, they follow directly on an excited emotion, such as anxiety or fear, and may be attributed to an imagination responsive to it, in the greater number of cases they are as involuntary as spasms or convulsions.

Now spectral and other illusions are very common in some forms of unsoundness, and they serve to explain, in part, the obstinate belief by which the mind is possessed. Thus a religious maniac, the author of a most interesting autobiography,* strongly confirmed by statements made to us by persons similarly afflicted, says, in reference to one of his many spectral illusions: "I imagined I was really present to *them;* and that my not acknowledging it was a delusion, an obstinate resistance of the Divine will on my part. That of the two, the appearance of the bed, walls, and furniture was false, *not* my preternatural impressions."

Spectral illusions, then, may occur in persons of sound and of unsound mind, the difference being, that the former do not believe in their reality, the latter do. The sane man corrects these false impressions by comparing them with those springing from the other senses, or with the sensations of others; while the man of unsound mind neglects these simple means of undeceiving himself, or cannot use them; or, if he entertain any doubt, dispels it by the help of his delusion. Thus, the author of the autobiography thought it *impious* to doubt.

Dreams.—The phenomena of dreaming have a striking analogy to those of some forms of unsound mind. The external world being shut out, and the higher faculties inactive, illusions and delusions have the vivid impress of reality, and follow each other according to associations over which we have no control. Many dreams are directly traceable to states of the body, which, when we are awake, produce pain or uneasiness, such as fulness of stomach, distension of bladder, or irritation of skin. The sleeper is conscious of this uneasy sensation, and seems to be seeking relief in unlikely ways and places, or he associates it with imaginary events. Thus a fit of indigestion is converted into *a nightmare*, and the ruffled dressing of a blister on the head suggests a dream of being scalped by savages. In other instances the uneasy sensation gives rise to a dream which has no other

* 'A Narrative of the Treatment experienced by a Gentleman during a state of Mental Derangement,' p. 63.

relation to the sensation itself than that of being painful or disagreeable; or it induces a state of mind favourable to the blending together of disconnected occurrences, recent or remote, having nothing in common but the feeling of annoyance or discomfort. We hear of a distressing accident; we receive bad news of an absent friend; and we have been concerned in some anxious business. a dream combines these scattered elements; we are ourselves connected with the accident; the absent friend is in our company; and the person with whom the business is transacted also appears on the scene.*

Dreams excited by certain sensations are subject to a strange law: a sound which wakes the sleeper, occasions a dream that seems to have occupied a considerable time. Thus, "a gentleman dreamed that he had enlisted as a soldier, joined his regiment, deserted, was apprehended, carried back, tried, condemned to be shot, and at last led out for execution. After all the usual preparations, a gun was fired; he awoke with the report, and found that a noise in an adjoining room had both produced the dream and awakened him."

Blows on the head also occasion dreams, which appear to assume one of two forms. Either the immediate antecedent of the blow seems to occupy a long time, or some sensation accompanying it is indelibly impressed upon the memory. The superintendent of a lunatic asylum, as he was kneeling in chapel, received a blow on the head from a stone enclosed in a handkerchief. The man who dealt the blow rushed at him suddenly, screaming. The wounded man fell on the ground bleeding and insensible, and on recovering his senses, had no other recollection of what had taken place than that his assailant seemed to have come to him from a long distance, and during a long space of time. This is a good example of the first class. A striking illustration of the second class is afforded by a case tried at Cambridge before Mr. Baron Bramwell, March, 1868. James Williams, who had taken one Robert Lowe into his cart, which arrived safe at home, was found lying huddled up in a corner of it, insensible and covered with blood that had flowed from a number of severe incised wounds on the left side of his head. He was for some time in great danger, and but slowly recovered consciousness. But his mind continued to be a perfect blank as to the assault, and the circumstances that had preceded it. He

* The reader is referred to Dr. Abercrombie's well-known work, 'Inquiries concerning the Intellectual Powers, and the Investigation of Truth,' for many instructive facts relating to this subject; and for more full information on the physiology of the human mind, to the chapter on Mental Physiology and Pathology in Hooper's 'Physician's Vade Mecum.'

had no recollection of the prisoner or any one else riding in the cart with him. He stated, however, that he had constantly before his eyes, day and night, and could not rid himself of it, the impression of a certain cap and of a jacket, with buttons upon it unlike in size, shape, colour, and position. When brought in contact with the prisoner, and told to examine the jacket, he said, "I don't want to look at it twice. I can see every button of it, and every shape of it every day. If they were to put that dress among a hundred, I should pick it." Lowe was convicted, and sentenced to penal servitude for life.

The strong analogy that exists between dreams and certain forms of unsound mind, is shown in the examples cited at p. 205, and the passing of the one into the other, by the case of a maniac mentioned by Dr. Gregory, who for a week after his recovery was harassed in his dreams by the same rapid and tumultuous thoughts, and violent passions, by which he had been agitated during his insanity.

The case of M'Naughten may perhaps be cited as bearing a close resemblance to one class of dreams. The refusal of his father to take him into partnership originated in his mind a sense of hardship and injury: the Roman Catholics, the Police, and the Tories, being successively the theme of newspaper abuse, and being also represented as guilty of acts of injustice, impressed his mind with the same feeling. Hence the long dream of years, in which the sense of public injury was transferred to himself, till he became the fancied object of political persecution.

The difference between dreaming and insanity is, that in the one, the senses are closed to outward objects; in the other, the evidence of sense is disregarded, or the senses merely suggest trains of wild and fanciful association, illusions blended with objects rightly perceived being perverted and misinterpreted by the help of the prevailing delusion. As soon as the dreamer is roused from sleep, and the outer world is again brought before him, all his illusions and delusions vanish; but the madman is in a waking dream, from which he cannot be roused.

Legal relations of Dreaming.—A question of criminal responsibility arises in those rare cases in which a man suddenly roused from sleep kills another. Such was the case of Bernard Schedmaizig, who suddenly waking at midnight thought he saw a frightful phantom, which giving no answer to his challenge twice repeated, and seeming to advance upon him, he attacked it with a hatchet that lay beside him. He had murdered his wife. Ray also relates the case of two men, who being out at night in a place infested with robbers, engaged that one should watch

while the other slept; but the former falling asleep, and dreaming that he was pursued, shot his companion through the heart. Again, there is the case of the pedlar, who being rudely roused from sleep by a passer-by, ran him through the body with the blade of a sword-stick; and was found guilty.* If these cases are rightly reported, it is difficult to understand how the homicidal act should he deemed criminal.

Somnambulism.—This is a form of dreaming in which the senses and voluntary muscles have full play; the one exercised with extraordinary acuteness on the subject-matter of the dream, the other obeying the mandates of the sleeper's will with unwonted precision. The mind during the dream is so concentrated on one object, that the reason or fancy will accomplish tasks to which it is unequal during the waking hours; and this concentration probably accounts for that extraordinary acuteness of the senses, that precision of movement, and that total absence of fear which marks such acts as walking on the edge of a precipice, swimming a rapid stream, or riding at full gallop. Some sleep-walkers, at each recurrence of the fit, perform some routine duty with all the precision of their waking hours.

In some cases, so complete is the mind's abstraction, that the loudest noises are unheeded; in others, those things only are attended to which harmonize with the existing train of thought. After the fit, there is either complete unconsciousness of what has occurred, or such remembrance of it as in an ordinary dream. In some cases, that which has transpired in one fit only, is distinctly remembered in subsequent ones, but quite forgotten in the intervals.

The analogy already pointed out between dreaming and insanity extends to some cases, at least, of somnambulism; for in some madmen, as in some somnambulists, there is a remarkable increase of talent, in others a complete change of character; in other words, there may be an intellectual and moral somnambulism, as there is an intellectual and moral insanity. The following cases support this view. A Carthusian monk, remarkable for simplicity, candour, and probity, walked almost every night in his sleep, a thief, and a plunderer of the dead. A pious clergyman, in his fits of somnambulism, would steal and secrete whatever he could lay his hands upon, and even plundered his own church. A suicidal somnambulist had fits every night, and required to be watched, as if suffering from an acute disease. He always tried to escape; and one night having succeeded, was

* These cases are quoted by Dr. Forbes Winslow in his 'Plea of Insanity in Criminal Cases,' the first from Dr. Pagan, the last from the 'British and Foreign Medical Review.'

found hanging by the feet from the limb of a high tree.* Homicidal somnambulism is illustrated by the following case. Late one evening a monk entered the room of the prior of the convent, his eyes open and fixed, a frown on his features, and a knife in his hand. He walked straight up to the bed, as if to ascertain if the prior were there, and then gave three stabs, which penetrated the bed-clothes and a mat that served the purpose of a mattress. He then returned with his features relaxed, and wearing an air of satisfaction. The next day, on being questioned, he confessed, that having dreamed that his mother had been murdered by the prior, and that her spirit had appeared to him, and cried for vengeance, he was transported with fury, and ran directly to stab her assassin. Shortly after he awoke, covered with perspiration, rejoiced to find that it was only a dream.†

Legal relations of somnambulism.—A question has been raised as to the responsibility of the somnambulist for acts committed during the fit, and an attempt has been made to show that, as what is done in the fit is often only the accomplishment of a project formed while he was awake, he ought to be held responsible. This is a perfectly gratuitous assumption, that cannot be seriously entertained till some fact shall have been advanced in its support. If such a question of responsibility should arise, it ought to be shown that the sleep-walking was not feigned, and that the accused was subject to it.

For some interesting cases of ecstasis, or cataleptic somnambulism, which is nearly allied to hysteria, and almost invariably occurs in females, the reader is referred to Abercrombie on the Intellectual Powers.

II. DELIRIUM, DELIRIUM TREMENS, AND DRUNKENNESS.

Delirium occurs in most severe febrile and inflammatory diseases, especially those which attack the internal viscera; is a common sequence of severe accidents, and surgical operations; and often ushers in the fatal termination of chronic disorders.

Febrile delirium is generally preceded by pain and throbbing in the head, heat of scalp, and flushing of face; but it sometimes makes its attack suddenly. In the first class of cases it is often preceded by dreaming. The patient talks in his sleep, and wakes up confused and forgetful; but when fully roused, is

* 'A Treatise on the Medical Jurisprudence of Insanity.' By J. Ray, M.D.
† Quoted from an anonymous work by Georget, 'Des Maladies Mentales,' p. 127.

collected, and so remains till the next slumber. By degrees this disturbed sleep passes into waking delirium. The patient lies on his back, dull and listless, with eyes half open, muttering to himself, unconscious of persons or things around him, and when roused scarcely recognising them. As the disorder increases and the strength fails, the voice becomes more indistinct, the fingers are constantly picking at the bed-clothes, the evacuations pass unconsciously, and the patient can no longer be roused to an effort of attention.

If delirium occurs at an earlier stage of the disease, or before the strength has been much impaired, the symptoms are somewhat modified. The eyes are bloodshot, and intently fixed as if on some object really present. The patient talks loudly and earnestly, tosses restlessly about, makes repeated attempts to leave his bed, perhaps escapes from the attendants, displays great strength and activity, and may even commit acts of fatal violence.

In fatal cases, delirium usually passes into coma, but occasionally it disappears some hours or days before death, leaving the patient in full possession of his faculties.

In some cases, again, the memory of things long past revives, and languages in complete disuse are recollected and spoken with fluency.

Delirium is an almost constant symptom of poisoning by belladonna, hyoscyamus, and stramonium; a frequent result of poisoning by other narcotico-acrids; an occasional one in poisoning by the pure narcotic and irritant poisons.

Delirium closely resembles that form of unsound mind known as incoherence, but is distinguished from it by its history. Delirium, when not caused by poison, is a symptom of some well-marked disease, generally febrile or inflammatory, while incoherence is rarely accompanied by bodily disorder, till it has lasted long enough to become associated with paralysis.

Legal relations of delirium.—Civil acts performed during an access of delirium are necessarily void, and criminal acts entail no responsibility. The validity of wills made by patients labouring under diseases attended with delirium is usually decided less by the proved existence of a lucid interval, than by the character of the will itself. If in keeping with the testator's known character, and with intentions expressed or instructions given when sound in mind and body; if the several parts are consistent with each other; and if no improper influence was brought to bear upon him; the will would be declared valid, even though the medical evidence threw doubts on his capacity. On the

other hand, in the absence of these conditions, the will would generally be declared invalid, in spite of the strongest evidence of the testator's capacity.

It is important to distinguish delirium, with intervals of perfect consciousness, from the calmness of demeanour sometimes assumed by patients labouring under strange delusions, the result of unsoundness of mind showing itself in the first stage of convalescence from fever or other acute disease; or as part of delirium tremens brought on by drinking. Here, too, the history of the case, and the state of the patient, will have to be carefully considered.

Delirium Tremens.—The delirium of drunkards is easily recognised by the peculiar form which the mental unsoundness assumes, and by the equally characteristic bodily symptoms, aided by the previous history; and, in most cases, by the prompt cure effected by the usual remedies—alcoholic stimulants and opiates, and nutritious food.

The patient is restless, sleepless, timid, suspicious, and cunning. He is subject to illusions of the senses, and fancies himself surrounded by hideous and loathsome objects, such as toads, serpents, and scorpions, and that he is persecuted by strange sounds and threatening voices; or he thinks that thieves or evil spirits are breaking into the house. When under treatment he is suspicious of the attendants, is constantly trying to escape; and, if not properly watched, may do violence to himself or others. Some patients display a painful eagerness to go somewhere, or do something on which their minds are bent. In extreme cases the patient exhibits all the symptoms of acute mania. The bodily symptoms consist of the tremor from which the disease derives its name, with a pale, cold, clammy skin, a moist, white, tremulous tongue, and a small weak pulse. The history of the case is that of a course of intemperance terminated by a short supply of liquor, or by some exhausting disease or surgical injury. Sometimes it follows a single debauch, especially in men who have had previous attacks of mania, or of cerebral inflammation, or who have suffered from severe falls or blows on the head.

In the milder forms of the affection, the patient goes about as usual, answers questions collectedly, and converses rationally; but when left to himself, he is as one in a waking dream, speaking of things calculated strongly to excite the feelings and passions with a manner perfectly free from excitement; *e.g.*, asking the porter of the out-patients whether he did not say that he would kill him.

Prolonged abstinence, too close attention to study or business.

and solitary confinement, sometimes bring on a state closely allied to delirium tremens, and characterized like it by illusions of sight and hearing.

Legal Relations of Delirium Tremens.—As delirium tremens is a recognised disease, with mental unsoundness as a symptom, the patient cannot be held responsible for his acts. Accordingly though drunkenness has no effect on civil or criminal acts, delirium tremens has the same effect as insanity itself.

Drunkenness.—The excitement which, in persons of sound mind, attends the indulgence in alcoholic liquors, is converted, in those of unsound mind, into maniacal incoherence, distinguishable from mania due to other causes only by the history of the case and the evidence of the sense of smell. A craving after spirituous liquors is one of the recognised forms of unsound mind (dipsomania); while in others it is merely a leading symptom of a more general disorder. In some cases the craving after alcoholic liquors shows itself only at intervals.

Legal Relations of Drunkenness.—This has no legal effect. It neither increases nor mitigates the penalties that attach to crime, and it has even been deemed an aggravation. A drunkard's acts are therefore valid, unless it can be shown that the drunkenness was procured by another person to obtain an unfair advantage.

III. OF THE SEVERAL FORMS OF UNSOUND MIND.

These resolve themselves, as already stated, into three leading classes, *Amentia*, *Dementia*, and *Mania*.

AMENTIA.

Of this form there are two species, *idiocy* and *imbecility*, as well as the mental defect traceable to local causes and known as *cretinism*.

Idiocy.—The best legal and medical writers agree in describing idiocy as a congenital malady, and the idiot as one "who from his nativity by a perpetual infirmity is *non compos mentis*." But some writers of both professions have used the term with less precision, evidently confounding the idiot with the victim of dementia, or even of mania. The time for such confusion of terms is past, and there is now a clear understanding that idiocy is a congenital absence or serious defect of all the mental faculties; but a state admitting of degrees, and, like other forms of unsoundness, not allowing of strict definition.

In its lowest form it combines the extreme of bodily deformity with an existence purely vegetative. Such idiots seem devoid even of sensation, and would perish if not closely attended to. In a

somewhat higher form there are sensations of heat and cold, of hunger and thirst, and just intelligence enough to indicate the commonest wants by signs. A still higher class consists of those idiots who have sensation and consciousness, recognise familiar persons and objects, are susceptible of attachment, can move from place to place, are able to make known their wants by gestures and sounds, or even by words imperfectly articulated, can be made to acquire habits of decency, can learn to hum or sing, or even to perform the simpler operations of arithmetic, and are susceptible of some improvement in their bodily and mental condition under careful, assidnous, and skilful teachers.

As a rule, idiots are deformed in body as well as stunted in intellect. They have small, misshapen heads, and features ill-formed and distorted—squinting eyes, large gaping mouths with thick lips, irregular teeth, and sallow and unhealthy complexions. The limbs and trunk are also imperfectly developed, and their gait is awkward and unsteady. Some of their senses are wanting, and others very imperfect.

Fig. 21.

Fig. 21 (one of the graphic illustrations of the late Sir Alexander Morison*) shows the head of an idiot of this type, 28 years old, four feet and a half high, with flattened forehead, thick lips, and large gaping, slobbering mouth, and awkward unsteady gait, his favourite posture leaning against a door, and beating it gently with his head. His sense of touch is very obtuse; his utterance is limited to the monosyllable *tee, tee;* his temper is good, and he often laughs discordantly. He can feed, but cannot dress or undress, himself; is inattentive to the calls of nature; exhibits no affection; shows no shame; is not moved by music, and is said to be inclined to onanism.

The female figure, fig. 22, is 18 years old; has a small, flat head, is short of stature, but not deformed; has a vacant expression, and silly laugh; repeats the monosyllable *um, um*, and will repeat, parrot-like, the words *good day, good night.* She is

* The illustrations which follow are from the same source.

fond of sweets, and pleased with music. She puts a watch into her mouth. She feeds herself, but cannot dress or undress, and does not attend to the calls of nature.

Fig. 32.

The child whose portrait is given in fig. 32 belongs to the smaller class of idiots who are free from cranial and facial deformity. His age is six. He was born an idiot, but seems to have grown worse after attacks of measles and whooping-cough in his third year. His senses are perfect; he can say a few words, such as *mother*, and *poor boy*; has affection for his parents, takes an interest in watching his father at work, and exhibits slight power of imitation: feeds himself, but will eat fish and flesh raw; attends to the calls of nature; is very restless, and keeps up a continual whine.

Fig. 33.

Idiots at the age of puberty often display the sexual passion by offensive gestures and disgusting habits, are subject to violent outbursts of passion, and sometimes commit acts of atrocious cruelty.

The Legal Relations of Idiocy, in the sense here assigned to the term, are obvious. It implies complete civil disability, and irresponsibility.

Imbecility.—This term

is here used to designate a mental defect manifesting itself in infancy, as distinguished from that which is congenital.

In strictness of language, perhaps, idiocy and imbecility would be equally characterized as congenital defects, of which the more marked (idiocy) makes itself soonest known, while imbecility is not recognised till the faculties have been tested by education, and found wanting. It is also obvious that no sharp line of distinction can be drawn between the idiot and the imbecile, for the fainter shades of imbecility pass into the lighter tints of idiocy. But the possession by the imbecile of the faculty of speech, as distinguished from the parrot-like utterance of the few words which the idiot can learn is the best line of demarcation the case allows of.

Most imbeciles are intellectually as well as morally deficient. They have a limited power of acquiring or retaining knowledge; cannot understand or appreciate the customs of society or laws human and divine; cannot control their emotions and passions as men of sound mind can do. But there is a small exceptional class which exhibits intellectual deficiency without seriously offending against morality, and a larger one, which combines the highest intellectual endowments with utter incapacity in the conduct of life. There is, therefore, an intellectual, a moral, and a general imbecility, as there is an intellectual, moral, and general mania.

Fig. 24.

The first of the annexed illustrations (fig. 24) represents an imbecile thirty years of age, and four feet nine inches in height, who is described as having a very small head, and an expression of silliness in his countenance; his eye, however, is rather lively, and he possesses more intelligence than we should expect from his appearance; he can talk rationally upon common subjects, and makes himself useful. He has worked in servile offices.

The subject of the illustration in fig. 25, like the idiot child in

fig. 23, is well-formed in face and limb; is eighteen years old, and four feet nine inches high. He has good features, and an agreeable though somewhat vacant expression. He speaks plainly, answers questions rationally, and has been taught to read and write, is fond of music, for which he shows some talent, and he has a good voice, a correct ear, and sings very well. He has been a baker and a waiter at an inn; says that he will always be a good boy, be polite and bow to gentlemen on whom he may wait, and will work like anything if work be given him. He feeds, dresses, and undresses himself, and is attentive to the calls of nature. He is subject to epileptic fits, and is disposed to quarrel, to tell lies, and to indulge in a solitary vice.

Fig. 25.

Fig. 26 is the portrait of a man of forty, of weak intellect from birth, but capable of such education as fitted him for the post of a copying clerk. He fell into bad company, committed theft, and was tried, and acquitted on the ground of insanity. In general he is quiet, inoffensive, and taciturn, but answers simple questions rationally. He is subject to frequent attacks of excitement, preceded by shuffling of the feet. In these attacks, which last several days, he talks incoherently, is restless, and will strike and kick those about him. When he was about thirty years old, he

Fig. 26.

shut the door of his room, placed a long form close to the fire, laid himself on the form, and his head on the grate. He was found insensible, but on being removed to an open window, had copious bleeding from the nose, and soon came to his senses. His head was burnt to the bone.

The form of imbecility which is most common, and most important in a medico-legal point of view, is that which affects the intellect, the morals, and the prudential conduct of life. Persons who exhibit this threefold deficiency profit by education, so as to form and express simple ideas, to read, write, and count, and to become musicians, draughtsmen, or mechanics. They may even attain proficiency in some one branch of knowledge, or some one accomplishment. But they do not profit by the opportunities afforded them in the same degree as their neighbours, and they present great varieties of character. Some are fickle and changeable, and incapable of fixing their attention; others are methodical and persevering. Some are found fit only for the coarsest and rudest labours, while others are equal, with the assistance and guidance of others, to the conduct of business and management of property. Others know the value of money, and can give information on matters with which they are conversant, but are unequal to emergencies, and unable to sustain close conversation or argument. They are thoughtless, improvident, uneasy, and restless, and generally incapable of strong and steady attachment. There are many imbeciles among the lower orders of society. They are found following occupations requiring little sense or skill, and their neighbours look upon them as weak and singular persons, and tease and torment them accordingly; or they become lazy, drunken, and dissipated, and addicted to begging and petty larceny. Some, under slight temptation, and very inadequate motives, break out into fits of ungovernable passion, and commit acts of theft, arson, rape, or murder. "They steal adroitly, and hence are considered as very intelligent: they recommence their offences the moment they are released from confinement, and thus are believed to be obstinately perverse." "They have no idea, or a very imperfect one, of society, laws, morality, courts, and trials; and though they may have the idea of property, they have no conception of the consequences of theft. They may have been taught to refrain from injuring others, but they are ignorant of what would be done to them if guilty of incendiarism or murder." "Their conduct is actuated solely by the fear of punishment, when capable of experiencing that sentiment, and by their own desires." Georget, from whose work, 'Sur la Folie,' these passages are quoted, says that "these beings of limited capacity furnish to

the courts of justice, to prisons and scaffolds, more subjects than is generally supposed"—a statement the truth of which we are able to confirm by our own experience. (G.)

But imbecility, as already pointed out, is not always of this mixed character, displaying itself at the same time in the intellect, morals, and conduct. It is sometimes partial, affecting only or chiefly either the intellectual or the moral character. There may be, on the one hand, an inability to acquire and apply knowledge in persons who have a due sense of right, act with integrity, and perform every social duty; and, on the other, an unusual power of acquiring knowledge, with judgment, fancy and refined taste, but combined with feebleness of purpose, want of self control, ineptitude for business, disregard of duty, and want of common honesty. Such persons are known in society as weak, soft, easy, good-natured, well-meaning, good sort of people, and if possessed of brilliant talents, as having every sense but common sense. They are too easy to be just; too thoughtless to be honest. They have an instinctive horror of business, an aversion to their regular occupations, and a distaste for everything that wears the shape of a duty. They are utterly ignorant of the value of money, and the last use they make of it is to pay their debts. Each man among them has his own favourite form of extravagance, and his own mode of ruining himself. One calls an architect to his assistance; another an upholsterer; a third collects useful things which he never uses, or displays a curious taste in worthless trifles; or (worse still) becomes the incorrigible patron of mendicants and mendicant-thieves. These people are always forming acquaintances with unworthy persons, who find it worth their while to know and to flatter them. With all their easiness of disposition they have much warmth of temper and strength of passion. They are bad children, husbands, and fathers, because in these relations they have duties to perform. Throughout life they are weak, wavering, fickle, and self-willed as children; the source of constant anxiety and misery to their families; the prey of designing knaves; the expected inmates of gaols, workhouses and lunatic asylums.

These moral imbeciles remain at large, because the intellect being unaffected, they have no distinct delusions, and as weakness of intellect is a necessary ingredient in the legal idea of imbecility, the attempt to prove such persons of unsound mind, in a court of law, necessarily fails. That absence of moral sense, and corresponding want of self-control, which is the essence of their mental malady, can be proved only by the history of their daily life; a *history* often hard to obtain, and generally studiously withheld.

Imbeciles are sometimes as much under the dominion of

childish fancies as maniacs are of delusions. A commission of lunacy was granted in the case of a young gentleman, aged 20, who was the slave of a childish fancy for windmills, with an aversion equally strong to watermills. Having been placed under control in a place where there were no windmills, he cut the calves of a child's legs through to the bone, and stated that he should have taken away its life, that he might be tried for his act, and removed from a place where there were no windmills. He had always been violent when thwarted in his fancy, had threatened his keeper and members of his family, and had more than once made preparations for committing murder. When we chanced to see him in a distant asylum, he was expecting to be appointed head miller to a maniac who alleged, among other strange claims to dignity and importance, that he was king of England. (G.)

Legal Relations of Imbecility.—In respect to this form of mental unsoundness, two kinds of questions may arise—questions of *competency*, and questions of *responsibility*.

The *competency* of imbeciles to form contracts, and their validity when formed, has often engaged the attention of our law courts. Persons of weak mind have been brought by improper influence to ally themselves in marriage, and the validity of such marriages has been successfully disputed, as in the case of Portsmouth *v.* Portsmouth, in which, as in other instances that might be cited, the proof of imbecility was rightly drawn not from a few isolated facts, but from an investigation of the whole life, conduct, and character.

The competency of imbeciles to manage their affairs is often called in question. As the conduct of life is partly dependent on a knowledge of the use and value of money, partly on judgment and discretion, inquiries of this class may assume a very simple, or a very complicated shape.

In rare instances men have been pronounced incapable of managing their affairs, on the ground not so much of general weakness of intellect, as of defective knowledge of numbers and the value of money. Two such cases are related by Abercrombie, in one of which there was a "total inability to perform the most simple process of arithmetic," and in the other "a total want of the power of tracing relations both as to time and numbers." In the face of evidence showing that they had made much progress in their education, both were pronounced incapable of managing their affairs.

An imbecile in whose case we were called to give evidence, did not know how *many pence* there were in a sixpence or shilling,

or how many shillings in a sovereign; could not perform the easiest operation of arithmetic; did not know the date, month, or year; or the name of the reigning monarch; nor recognise persons with whom he had conversed only four days previously. His attention was roused with the utmost difficulty, and could not be fixed to any one subject. His look was vacant, his dress peculiar, his gait awkward, his motions grotesque, his speech slow and hesitating. He used the same words and expressions again and again, repeated imperfectly the tasks and prayers of his childhood, and imitated the contortions of persons, like himself, subject to fits. Such a case could present no difficulty either to witness or jury. (G.)

More difficult questions arise in respect of persons who though they display many marks of imbecility, in childish ways, eccentric habits, violent passions, and cruel dispositions, are yet able to perform the simple operations of arithmetic, know the value of money, and can comprehend such statements and suggestions with respect to their affairs as are submitted to them. In some of these cases, a successful appeal has been made to the efficient manner in which the party has actually conducted his own affairs.

The proof of imbecility, combined with undue influence, has, in many instances, been held to invalidate a will; but, in the absence of such influence, all that is required to establish the wills of people of weak understanding is, that they should have been capable of comprehending their nature and effect.

The question of *responsibility* for such acts as arson and murder, can only be answered by weighing well all the circumstances of the act, the motives by which it was instigated, and the whole life and character of the accused. This subject will be considered when all the forms of unsound mind have been passed in review.

Several interesting and instructive cases of imbeciles, concerning whom the two questions of competency and responsibility have been raised, are given in detail, and made the subject of judicious commentary in Ray's 'Treatise on the Medical Jurisprudence of Insanity.'

Cretinism.—In many parts of the continent of Europe, especially in valleys lying among hills, but occasionally in unhealthy rural and urban districts in all parts of the world, a disease prevails which combines the extreme of bodily deformity and degeneracy with deficiency of intellect. In Switzerland and Savoy persons so afflicted are called *cretins*, and in France *cagots*. The morbid feature by which they are chiefly distinguished is the enlargement of the throat, known as *goitre* or *bronchocele*; but to this several

bodily defects and deformities are superadded. The stature is dwarfed, the belly large, the legs small, the head conical, the arch of the palate high and narrow, the teeth irregular, the mouth large, the lips thick, the complexion sallow, the voice harsh and shrill, the speech thick and indistinct, the eyes squinting, the gait feeble and unsteady, the sexual power weak, or wanting.

The best authorities represent this physical degeneracy, with the coexisting mental deficiency, as commonly dating, with rare exceptions, from a period subsequent to birth. About the fifth or sixth month, the bodily development seems to be checked. The child looks unhealthy and seems weak; the head is large, and its bones widely separated; the belly swells and the limbs shrink; teething goes on very slowly, and the child cannot stand or speak till its fifth or sixth year. Some cases are complicated with spinal distortion, some with hydrocephalus.

The victims of this singular affection are usually divided into three classes—cretins, semi-cretins, and the cretinous, or cretins of the third degree.

The first class answer to the description of idiocy already given, with the addition of the peculiar deformity of the throat. Their life is automatic; they have no intelligence; their senses are dull, or wholly wanting; they cannot speak; their time is spent in basking in the sun or sitting by the fire; and only the most urgent calls of nature rouse their attention. They do not possess the power of reproduction. The next class, or semi-cretins, show a higher intelligence. They can be taught to read and to repeat prayers, but without understanding what they learn; they have no idea of numbers; they note what passes around them, and use language to express their wants; they remember common events, understand what is said to them, and speak intelligibly on common subjects. Cretins of the third degree show glimpses of a higher nature, and can attain a certain degree of proficiency in mechanical employments and contrivances, in drawing, painting, and music; but arithmetic is a very rare acquirement. They are said to be acutely alive to their own interest, extremely litigious, unable to manage their affairs, but obstinate and unwilling to be advised.

Cretins of the second and third degrees, if removed from their birth-place early in life, and put under judicious superintendence, may be greatly improved both in body and mind, and become useful members of society.

DEMENTIA.

This is readily distinguished from the two forms of *amentia* just described. In idiocy the deficiency is congenital; in im-

becility it shows itself in early life; but in dementia it supervenes slowly or suddenly in a mind already fully developed, and in childhood, manhood, or old age. It differs also from mania, for it consists in exhaustion and torpor of the faculties, not in violent and sustained excitement.

The mental state in dementia is best described by the word incoherence. There is also a form of mania equally well described by the same word; but the incoherence of dementia is marked by languor, that of mania by excitement. It must, however, be understood that the demented are liable to maniacal paroxysms, and maniacs to remissions of comparatively tranquil incoherence.

Dementia is divided into *acute*, or *primary*, and *chronic*, or *secondary*. The first form is rare, and consists in a state of profound melancholy or stupor; the second very common, and characterized by incoherence. There is also a Senile Dementia, and a form of dementia associated with General Paralysis.

There are also degrees or stages of dementia, which Prichard indicated by the words forgetfulness, irrationality, incomprehension, and inappetency. A patient suffering from dementia, as he passed from bad to worse, would first exhibit want of memory, then loss of reasoning power, then inability to comprehend, and, lastly, an abolition of the common instincts and of volition.

1. *Acute Dementia.*—That form of *dementia* which arises from sudden mental shocks often presents a distinct and very peculiar feature.—The mind is, as it were, arrested and fixed for the remainder of life in sad abstraction on the one event which had occasioned it; or the shock destroys all mental power, and brings on a state similar to that of the imbecile or idiot.

During the earthquake panic of 1843, we saw a case of dementia in a lad twelve years of age, brought on by the alarming conversation of a knot of Irishmen in the dusk of the evening. The poor boy seemed deprived of all his faculties, was dull and listless, and answered every inquiry by a vacant smile. He had an occasional access of terror and excitement, but soon relapsed into stupor. (G.)

2. *Chronic Dementia.*—This form may generally be traced to some antecedent acting gradually on the mind, such as prolonged grief or anxiety; to severe attacks of fever, mania, melancholia, apoplexy, paralysis, or repeated fits of epilepsy. In all these cases it may depend on softening or other chronic disease of the brain. It may be inferred from two melancholy cases of recent occurrence that the inhalation of one poisonous vapour at least

(mercuric methyl) can induce in healthy men a state of brain passing gradually into the most hopeless dementia.

3. *Senile Dementia*, or that which is incidental to aged persons, is a simple and well-marked form of the dementia which arises from causes acting slowly and gradually. The first symptom is impaired memory of recent events, with dulness of perception and apprehension, and an inability to fix the attention, or follow any train of thought. The things heard five minutes since are forgotten, and the same question is repeated again and again. Hence, the transaction of business requiring sustained attention becomes impossible. The control of the will over the thoughts becoming more and more enfeebled, the reasoning powers suffer; for scarcely are the premisses laid down before they are forgotten, so that the act of comparison by which the conclusion is arrived at cannot be performed; and after pursuing the same topic of conversation through part of a sentence, some accidental suggestion turns the ideas aside. Persons so affected know their attendants and recognise their friends, but they seldom display signs of emotion on seeing them; and they can still employ themselves mechanically,—men in writing, and women in knitting and sewing. The next phase of the malady is one of complete incomprehension. Memory, reason, and the power of attention are entirely lost; but the muscular force remains intact, and displays itself in perpetual activity, in jumping or running to and fro, or walking round in a circle, or rocking backwards and forwards in a chair, dancing, singing, and shouting, or in talking or muttering incessantly. Many, however, sit silent and tranquil, or with a vacant unmeaning stare, for weeks, months, or even years. A few remain crouched in one uneasy posture, or they stand erect with the neck rigidly fixed at right angles to the body. Some display obstinate delusions. In the last stage of all, even the animal instincts are lost; there is neither sensation, memory, thought, nor reason, but bare physical existence; with occasionally, at distant intervals, a short resuscitation of some of the mental powers.

4. *General Paralysis* (*Paresis*).—The weakened state of the mind in this interesting form of dementia shows itself in most cases by delusions of unlimited power and boundless wealth; in all by progressive decay of bodily and mental power. Among the early symptoms are neglect of duty, a restless and wandering disposition, the commission of petty thefts, indecent exposure of the person, acts of extravagance, and a sudden change of opinion and feeling, moral and religious. The disease is rare in women, common in men of education and position; and it generally

shows itself in adults of middle age—from thirty to sixty. Its causes are intemperance, sexual excesses, the anxieties and undue mental labours of the active and stirring period of life, and hereditary taint. The mental defect is sometimes recognised before the paralysis, sometimes with it, and sometimes the spinal marrow is first affected, then the structure and functions of the brain. Its duration is usually stated at from a few months to three years. The paralytic symptoms show themselves first in the tongue, lips, and features. The articulation is hesitating and indistinct, the lips, tongue, and muscles of the face are tremulous and quivering; the pupils are often unequally dilated. Then the muscles of the limbs are affected. The patient trips, stumbles, and staggers, and can no longer perform such combined muscular movements as playing on musical instruments, writing, and sewing. These paralytic symptoms go on increasing, and, at length, the sphincters cease to act, and it is not uncommon for death to happen from suffocation in the act of swallowing food. Occasional fits of violence and of epilepsy occur to vary what would otherwise generally prove a gradual descent towards death, with increasing weakness and helplessness. At the last, sloughing bed-sores, and attacks of diarrhœa or pneumonia close the scene. One noteworthy and characteristic feature of the malady is the change in the expression of the countenance in an early stage. Through the relaxation of the muscles, the wrinkles of the face disappear, and the patient seems to have grown younger; but at a later stage, the face becomes curiously wanting in expression. But to the last the mental characteristics remain the same, and the last muttered words are about "gold, and carriages, and millions of money."*

The figures annexed (see next page) represent the early and advanced stage of General Paralysis in a gardener, æt. 38. The misconduct of a daughter had brought on a state of melancholy which lasted for a fortnight, at the end of which time he began to insist that he was the king, that he was in his palace, which was made of gold, and that he had a million of money. His memory failed him, he did not know the month or year, his speech was slightly impaired, but his walk was tolerably firm. Fig. 27 was taken a month after the appearance of these symptoms, and fig. 28 after the lapse of another month, when the disease had made much progress, as was shown by the increased embarrassment of his speech, the nearly utter loss of memory,

* L. Meyer: quoted by Maudsley in his 'Physiology and Pathology of the Mind,' p. 384.

his tottering gait (for he could scarcely walk at all), and, notwithstanding a very good appetite, his rapid emaciation.

Fig. 27.

Fig. 28.

Legal Relations of Dementia.—Dementia is a common subject of the inquiry *de lunatico*. A demented person lapses into habits of ruinous extravagance, and the inquiry has for its object to ascertain whether he is able to manage his affairs, and if not, since what date the incapacity has existed. This inquiry, difficult in itself, is made more embarrassing by the strong rival interests which always grow up around persons of this class.

A question frequently raised respecting this form of unsoundness relates to the validity of wills made or altered by persons alleged to be suffering from senile dementia. The inquiry is generally one of considerable difficulty; for such persons vary greatly from day to day, and present themselves to different observers in different lights. Accordingly there is room for very conflicting testimony, and wide divergences of opinion, both among unskilled and skilled witnesses; and the legal decision ultimately turns much more on the character of the will itself and its consonancy, or otherwise, with the known intentions and views of the testator at an earlier period of his life, and with the natural feelings of persons of sound intellect, than on the medical or other evidence respecting his mental condition.

General paralysis, in any degree, affords a strong presumption against the competency of the subject of it, implying, as a very

general rule, exaggerated ideas of wealth, and inability to make a reasonable use of money.

The responsibility of the demented for acts which in the sane are crimes will be considered presently.

MANIA.

This term includes all the forms of unsoundness that are characterized by undue excitement; and therefore differs in a marked manner from those already described. There is no legal term in common use which properly characterizes this state; and one of its most important forms, moral insanity, is as yet unrecognised by the law. The only legal term employed in a sense analogous to that of mania is *lunacy*, which, as already remarked, is objectionable from being founded on a variable feature of the disease.

There are three forms of Mania (table, p. 168); *General*, *Intellectual*, and *Moral*; and each of the two latter has two subdivisions—*General* and *Partial*.

General Mania.—This form affects the intellect, the emotions, and the passions, and throws the whole mind into a state of mingled excitement and confusion. It is the counterpart of the incoherence of dementia, and the form which, in some cases, mania assumes from the very first. It would be correctly designated by the phrase "raging incoherence." There is another form liable to be confounded with this, on the one hand, and with monomania on the other, but which, when carefully examined, is found to be a general unsoundness, with undue excitement of some predominant emotion or passion that takes the lead in the unsound, as it had previously done in the sound mind.

Mania, whatever form it assumes, unless it be the immediate consequence of injuries, moral shocks, intoxication, poisoning, or acute disease, is commonly preceded by important bodily and mental changes, which take place gradually, occupying a variable period of time, from a few days, to 15 or 20 years, and is known as the period of *incubation*.

When the period is short, the disease shows itself at the end of some hours or days of anxiety, uneasiness, and depression, by headache, sleeplessness, and excitement. The patient begins to babble, cry, and sing, becomes wild and agitated, and appears like a person intoxicated. When the period of incubation is extended, the disease generally commences with a consciousness on the part of the patient of some disorder in his mental faculties, *of odd notions*, unusual inclinations, and changing affections. He *is vexed* at the change, and tries to conceal it; continues his

occupations; and, like a man in the first stage of intoxication, makes great efforts to appear reasonable. Meanwhile his health gives way. His sleep is disturbed; he loses flesh and appetite; and suffers from indigestion and constipation. At the same time, a great change takes place in his tastes, habits, affections, and character, and in his aptitude for business. If he was gay, communicative, and social, he becomes sad, morose, and averse to society; tears and laughter succeed each other without apparent cause; if open and candid, he becomes suspicious and jealous; if moderate in his political and religious opinions, he passes to an extreme exaggeration in both; if affectionately attached to wife, children, and relations, he regards them with indifference or dislike; if he was orderly and economical, he becomes confused and prodigal; if correct in conversation, his language becomes violent and obscene; if chaste, or moderate in sexual indulgence, he becomes the victim of insatiable desires, and either seeks to associate with the other sex, or has recourse to disgraceful practices.

If this is a first attack, the nature of the change is misunderstood; questions are put to him which harass and pain him, or he is irritated by offensive insinuations and frivolous accusations: and when, at length, he breaks out into furious mania, the attack is attributed to some cause quite inadequate to produce it.

The period of incubation passed, and the disease fully established, the mental and physical phenomena undergo a change. The patient has faith in his delusions, and instead of concealing his thoughts, openly and strenuously avows them, except when tempted by powerful motives to a contrary course. When thwarted and opposed he uses the most violent, obscene, and insulting language. Nor does his violence always spend itself in words, for he tears his clothes and bedding to pieces, and inflicts bodily injury on himself and those about him. The physical derangement displays itself in a flushed face, a wild sparkling eye, pain, weight and giddiness in the head, ringing in the ears, restlessness and sleeplessness. The patient is also singularly insensible to cold and heat, and either abstains from food and drink during long intervals of time, or eats voraciously. His muscular power is inordinately developed, and he sustains for a long time, without sleep, a succession of efforts which would soon utterly exhaust a healthy person. His habits are often most disgusting and offensive.

The appearance of the maniac during the fits, and in comparatively tranquil and lucid intervals, is well shown in the annexed figures, of which fig. 29 *shows* an epileptic maniac, æt. 60, in a

paroxysm, and fig. 30 the same person, calm, collected, and well behaved.

Fig. 29.

Fig. 30.

General Intellectual Mania.—The opinion is gaining ground that mania is in all cases primarily an emotional disease, and that the affection of the intellect is secondary. But there is certainly one class of cases in which the disease appears to be almost limited to the senses, which are the sport of strange illusions, or to the intellectual faculties, properly so called. Of the first class we have at least three good examples in the estimable gentleman of Argos, immortalized by Horace,

> "Qui se credebat miros audire tragœdos,
> In vacuo lætus sessor plausorque theatro;"

in another at Abydos mentioned by Aristotle, and in the patient of "exalted rank" whom Sir Henry Halford saw in his fancied theatre, and heard "call upon Mr. Garrick to exert himself in the performance of Hamlet." In these cases it is believed that these mixed illusions of sight and hearing, looked upon as real, constituted the whole of the unsoundness. Of the second class a few examples might also be found, as in a gentleman who thought himself secretary to the moon, but does not seem to have carried his unsoundness into sublunary affairs.

But there is certainly a very distinct and well-marked class of cases wrongly regarded as intellectual, but really dependent on

the excitement of some strong emotion or passion, such as pride, vanity, or ambition. Thus Dr. Reid tells us of a vain young medical student, who, expecting to realize a fortune by attaining academical honours, entered himself at Cambridge, and so injured his health by fruitless application to study, as at length to fall into a state of decided derangement, alleging that he was the Farnese Hercules; had written Dr. Clarke's Travels in Russia; had composed the Æneid of Virgil; had painted one of the masterpieces of Raffaelle, and knew everything.

Dr. Henry Johnson, in his work on the arrangement and nomenclature of Mental Disorders, also gives the highly characteristic letter of an ambitious patient who claimed the somewhat incongruous titles of champion and king of England, and heir presumptive to the crown, at the same time that he monopolized all the principal offices of state.

The autobiography, already referred to, of a gentleman who had recovered from an attack of mania, shows how general was the disturbance of the whole intellectual and moral being; though the predominant emotion being of a religious character, the case might have been described as one of religious monomania.

General intellectual mania consists, then, in many cases, in a violent disturbance of all the intellectual faculties brought about by the over-excitement of some one leading emotion or passion.

Partial Intellectual Mania.—This was called melancholia, from the mistaken notion that such partial affections of the intellect are always of a gloomy character. But Esquirol showed that such persons have often extremely gay and pleasant ideas, and substituted the term monomania, now generally received.

The simplest form of this disorder is that in which the patient takes up some one notion opposed to common sense and universal experience. He is secretary to the moon, the Crystal Palace, a grain of wheat, a goose-pie, a pitcher of oil, a wolf, a dog, or a cat.

In many cases, this single delusive idea relates to, or is occasioned by, some sensation or disease, which the monomaniac, like the dreamer, associates with imaginary accompaniments, and interprets by the aid of his delusion. Thus, Esquirol tells us of a woman having hydatids in the womb, who insisted that she was pregnant with the devil: of another, who having adhesions of the intestines after chronic peritonitis, imagined that a regiment of soldiers lay concealed in her belly, struggling and fighting; and of a third, who, suffering in the same way, believed that the apostles and evangelists had taken up their abode in her bowels, and were occasionally visited by the Pope and the patriarchs of the Old Testament.

But such delusions as these, though originally founded on real sensations, may continue after the sensations themselves have passed away, as is proved by the cures that have been wrought by a laudable species of deception. Thus, a patient, thinking that a serpent had been extracted from his bowels by a pretended surgical operation, took up the idea that the creature had left its ova behind, ready to be hatched into a brood of young ones; but was reassured by the dexterous reply, that the snake was a male.

But such cases of partial intellectual mania do not comprise all those designated as *monomania;* for in most instances the mental affection goes beyond a single insane idea, and influences more or less extensively the thoughts and the conduct, being marked by other intellectual and moral inconsistencies.

Moral Mania.—It was Pinel who first recognised this form of insanity, the disease having been previously considered as either exclusively, or chiefly, a malady of the reasoning faculties. He found, to his great surprise, that there were at the Bicêtre many maniacs "who betrayed no lesion whatever of the understanding, but were under the dominion of instinctive and abstract fury, as if the affective faculties alone had sustained injury." This he called *manie sans délire.* The reality and great importance of this distinction between intellectual and moral mania are now universally recognised; and with it the further fact that moral generally precedes intellectual, insanity. Prichard, an able writer on this subject, defines moral mania as "a morbid perversion of the natural feelings, affections, inclinations, temper, habits, and moral dispositions, without any notable lesion of the intellect, or knowing and reasoning faculties, and particularly without any maniacal hallucination."

Moral mania, like the intellectual form, may be either *general* or *partial.*

General Moral Mania.—Prichard observes that there are many persons living at large in society who are reputed to be singular, wayward, and eccentric. An attentive observer will recognise something remarkable in their manners and habits, which may lead him to doubt their sanity; and often on inquiry his suspicions are strengthened by finding that an hereditary tendency to madness exists in the family, that several of the relations have laboured under other diseases of the brain, or that the individual himself has formerly had a decided attack of madness. His temper and disposition are found to have changed; to be not what they were previous to a certain time; and the change *may* perhaps be traced to a period when he had a reverse of fortune, or lost some beloved relative, or sustained some severe con-

stitutional shock, some febrile or inflammatory disorder affecting the brain, a slight attack of palsy, or a fit of epilepsy. In some cases, the alteration in temper and habits has been gradual and imperceptible, and seems to have consisted merely in an exaltation or increase of peculiarities always more or less natural and habitual. These persons are capable of reasoning or supporting an argument on any subject within their sphere of knowledge; and they often display great ingenuity in justifying and explaining their feelings and conduct. In one sense, indeed, their intellectual faculties may be termed unsound; they think and act under the influence of the same strongly-excited feelings which render sane persons proverbially liable to error both in judgment and conduct.

Hoffbauer, too, recognises this moral form of mania. "It is clear," he says, "that mania may exist uncomplicated with mental delusion; it is, in fact, only a kind of mental exaltation (*tollheit*), a state in which the reason has lost its empire over the passions and the actions by which they are manifested, to such a degree, that the individual can neither repress the former, nor abstain from the latter. It does not follow that he may not be in possession of his senses, and even of his usual intelligence, since, in order to resist the impulses of the passions, it is not sufficient that the reason should impart its counsels,—we must have the necessary power to obey them." Esquirol not only recognised this form of unsoundness, but even went so far as to declare "moral alienation to be the proper characteristic of mental derangement," adding that though "there are madmen in whom it is difficult to find any trace of hallucination, there are none in whom the passions and moral affections are not perverted and destroyed."

Moral insanity is illustrated in the works of Prichard and Ray, by several striking cases; the most remarkable, perhaps, being that of Frederick William of Prussia, father of Frederick the Great, a drinking and smoking hypochondriac, and the strange, wayward, and cruel tyrant of his family and household. His religious austerities, his disgusting and brutal behaviour to his children, his unfounded hatred of his own son, and repeated attempts on his life, his one attempt upon his own life, his course of steady and unswerving persecution of the innocent objects of his suspicion and dislike, without any delusion beyond that which might fairly be regarded as the offspring of his hate—present a striking picture of general moral mania.

Maudsley* gives us as "the extremest example of moral in-

* The 'Physiology and Pathology of the Mind,' p. 317.

sanity" he has seen, the case of an old man, æt. 69, who had been in one asylum or another for fifteen years. He had great intellectual power, could compose well, write tolerable poetry with much fluency, and was an excellent keeper of accounts. He had no delusion, but "morally he was utterly depraved." He would steal and hide whatever he could, and several times escaped from the asylum with marvellous ingenuity. He then pawned what he had stolen, begged, and lied with such plausibility that he deceived many people, until he got into the hands of the police, or was found in a wretched state in the worst company in the worst part of town. He had been several times in prison for stealing. In the asylum he was most troublesome, cunning, plausible, and treacherous; abusive, foul, and blasphemous in language; drew indecent pictures, and was guilty of most indecent acts. At long intervals, sometimes of two years, he fell into profound melancholy for two or three months, refused food, and was as plainly insane as any patient in the asylum. "In short, he had no moral sense whatever, while all the fault that could be found with his very acute intellect was, that it was entirely engaged in the service of his depravity."

Partial Moral Mania.—This consists in the intense activity of some one passion or propensity, and its predominance or complete mastery over every other. The persons so affected are usually perfectly conscious of their condition, and either evince the utmost horror at the conduct to which their ruling passion would impel them, and with difficulty restrain themselves, or they give way, as if in desperation, to the impulse.

There is no strong impulse of our nature that may not be thus placed, by morbid excitement, beyond the restraint of reason and conscience. The following forms are now generally recognised, and have received distinct names:—Kleptomania, Erotomania, Pyromania, Dipsomania, Suicidal Mania, Homicidal Mania. These are of special interest to the public and the legislature; but there are many other distinct varieties, some marked by extreme depression, and others by great excitement, which have been classed under the two heads of *Melancholia* and *Exaltation*, the first comprising the three species, hypochondriasis, nostalgia, and religious despair; the second, excessive pride, vanity, or ambition.

Kleptomania or *propensity to theft.*—This is of common occurrence in persons placed by their wealth beyond the reach of vulgar temptation; women being more subject to it than men. It is also a common feature of imbecility and of mania, and an incident of maniacal paroxysms. Prichard mentions the curious

case of a madman who would never eat his food unless he had previously stolen it.

Erotomania, or *amorous madness*.—This disease, known as *Satyriasis* when it attacks men, and *Nymphomania* when it occurs in women, sometimes afflicts virtuous females, who view their excited passions with horror and remorse.

Pyromania, or *propensity to incendiarism*.—This, in common with Kleptomania, is more frequent in women than in men, especially in young girls subject to menstrual suppression or disturbance. It is also very common in the imbecile tramps who infest our rural districts.

Dipsomania.—An excessive desire for drink, in some cases continuous, in others intermittent, is a well-recognised form of unsoundness. It may be part of a more general unsoundness, or the true source of all the manifestations of unsoundness the patient makes. He is perfectly rational when not under the influence of drink.

Suicidal Monomania.—There is much difference of opinion as to the real mental state of self-murderers. The fact of suicide having been generally practised and sanctioned by philosophers and lawgivers of past times, and of being still in common use in nations which have attained in many respects a high civilization, such as China and Japan, has led some to the belief that it is not always the result of an insane impulse. The calm and deliberate manner in which the act is often set about, and the plausible reasons alleged in its defence, have led some to doubt whether suicide is always an act of madness. Those who recognise a "folie raisonante," or have seen cases such as that which recently came under our own notice, of a young man who had displayed high talents, and achieved great distinction both at school and college, crowning a series of abortive attempts at suicide with one success, describing his own mental state in terms of singular clearness, as one to which we can attach no better epithet than *mental malaise* (G.), will not attach much importance to this doubt; but they will find a better reason for believing it to be, at least occasionally, independent of insanity in the fact, that in France two persons often combine for the purpose of self-destruction; such union of purpose being extremely rare in the case of the insane. Our own experience of suicide leads us to believe that it is often the result of a sudden impulse, on very slight provocation, of persons not previously depressed in mind. (G.)

The argument drawn from national usage in ancient and modern times has no great force; for who would hesitate to

characterize an English widow who should burn herself on the death of her husband, as insane? though such self-sacrifice was till recently a laudable custom in India; or though some savages eat human flesh, look upon the act of the French woman who killed her child, cooked and ate part of it, and offered the dish to her husband, as anything but a strong evidence of insanity?

A careful consideration of recorded cases of suicide must lead to the conclusion, that very many are the result of insane impulse, a conclusion strengthened by the frequent attempts at self-destruction made by some inmates of lunatic asylums. The strange modes of death sometimes selected might also be urged as an argument in favour of the insane origin of suicide. It may be added, that such high authorities as Foderé and Esquirol have strongly maintained the necessary dependence of suicide on insanity.

Homicidal Mania.—The best authorities, both at home and abroad, have recognised this form of mental unsoundness, as having an existence independent of delusion. The recorded cases are now very numerous, and comprise instances of successful resistance to the impulse, voluntary submission to restraint, and failure. Women seem to be more liable than men to this form of moral mania, even if we set apart some cases of infanticide as special instances of it. Women suffering from grief or anxiety, from habitual discharges, at the menstrual period, at the change of life, and soon after delivery, are thrown into a peculiar nervous state, known as *mimosis inquieta*, which is sometimes accompanied by a strong impulse to crime, with an overwhelming dread of giving way to it.

Puerperal Mania.—This is named after its cause, and not after any leading symptom. It attacks women who have been recently confined, generally at some period between the first suckling of the child and the last show of the lochia, and is sometimes occasioned by the suppression of the secretions of the breast or womb, but sometimes also in consequence of excessive lactation or profuse vaginal discharge, of great weakness however induced, or of want of sleep. The disease is rare before the third day, and most common between the fifth and fifteenth. The symptoms may be those of any of the leading forms of unsoundness; in many cases there is a strong homicidal tendency, and the child falls a victim to a sudden impulse, there being no assignable or imaginable motive, no concealment, and often no remorse.

Melancholia (Lypemania of Esquirol).—There are, as just

stated, three principal forms of melancholia, all characterized by profound sadness: *hypochondriasis*, consisting in a desponding view of the condition of the body and of the health, often, but not always, based on uneasy bodily sensations and disorders of the digestive organs; *nostalgia*, or an intense longing for country and home; and *religious despair*. The extreme form of melancholia, associated with some terrible delusion, in which the patient is fixed in one position, like a statue, has been distinguished as *melancholia attonita*.

Exaltation.—This opposite of melancholia prevails in those who exult in the belief that they are possessed of great personal attraction, great power, great dignity, great inventive faculties, or great projects of benevolence.

Melancholia and exaltation sometimes alternate in the same patient with some approach to regularity, constituting the form of unsoundness to which some French authors have given the name of *folie circulaire*, or *folie à double forme*.

Cases also abound, both inside and outside of our asylums, which warrant the use of a larger vocabulary of terms—cases, for instance, in which a lying or begging propensity, or a strange pleasure in the act of giving or spending money, is quite as clearly marked as a thieving propensity in those designated as Kleptomaniacs. Nor is it possible to omit the remarkable recorded cases of *lycanthropy*, one of which (that of the soldier Bertrand) occurred not many years since in France, the violation of the grave being with him an intermittent insane passion, which no sense of personal danger was allowed to disappoint.

The longings of pregnant women, carried to a strange excess in one who killed her husband, and pickled his body, to eat it (Maudsley); a persistent morbid desire to be hanged; and the killing of children by their fathers or mothers with the sincere purpose of sending them to heaven,—might also be properly described as distinct and well-defined forms of partial moral mania.

Of Mania with Lucid Intervals.—Mania, in many cases, assumes a recurrent or intermittent form, the patient in the interval being in his right mind. The proportion which these cases bear to those of complete recovery has been variously stated at from one in six to one in ten.

The interval is various. Esquirol has seen a quotidian, tertian, and quartan type, as well as the intervals of a month and of a year. More frequently the intervals and durations of attacks are alike uncertain. This recurrent mania, with intervals of complete sanity, must not be confounded with those periods of comparative tranquillity which, like lulls in a storm, occur in most cases of

mania. With regard to such intervals of comparative repose Haslam remarks that, "as a constant observer of this disease for more than twenty-five years, he cannot affirm that the lunatics, with whom he had daily intercourse, have manifested alternations of insanity and reason. They may at intervals become more tranquil, and less disposed to obtrude their distempered fancies into notice. For a time their minds may be less active, and the succession of their thoughts consequently more deliberate; they may endeavour to effect some desirable purpose, and artfully conceal their real opinions; but they have not abandoned or renounced their distempered notions."

The law generally views civil acts done in *lucid intervals* as performed by a person in a permanently sound state of mind; it acknowledges the validity of wills made during such intervals, and has, in more than one case, admitted the reasonableness of the will as proof of a lucid interval. With regard to criminal acts, it makes a reasonable distinction; for it justly regards the condition of unsoundness as one readily reproduced by provocation or excitement. The legal relations of the other forms of mania will be fully considered in the following division.

IV. OF THE MORE IMPORTANT CHARACTERS OF THE UNSOUND MIND, AND OF ITS MEDICAL AND LEGAL TESTS.

A knowledge of the leading characteristics of mental unsoundness is of the first importance both to the lawyer and to the physician. Without it a mere description of its several forms would present but an imperfect view of the subject. It is proposed, therefore, to establish, by appeals to facts, the more remarkable phenomena of mental unsoundness, as preliminary to the discussion of the chief legal questions that arise out of that state; and to prescribe, for the guidance of the medical witness, such rules as these phenomena shall be found to suggest for recognising it, and for distinguishing it from its counterfeit.

Of the Characters of Unsoundness of Mind arising from Defective Development or Diminished Activity.

The appearance of the idiot or imbecile is so peculiar that it scarcely requires to be confirmed by an actual inquiry into his mental condition. Difficulty in rousing and fixing the attention; slowness of apprehension; forgetfulness of recent occurrences; ignorance of social relations, of such familiar things as his age, the place in which he lives, the mode in which he passes his time, the year, the month, the day of the month and week, and of those *public persons* and events which are the common topics of con-

versation with those who take an interest in the common affairs of life, as the name of the reigning monarch, of the prime minister, &c.; a scanty acquaintance with arithmetic and the value of money; an imperfect knowledge of right and wrong, and of the law relating to the most common and familiar crimes;—may be mentioned among the characters of unsoundness from defective development.

In ordinary and extreme cases of imbecility there can be no difficulty in deciding on the competency of the individual to take care of his affairs, to form contracts, to devise property; but where the imbecility exists in a less degree, the question is not so simple; and especially when the subject of inquiry has been entrusted with, or consulted about, the management of his affairs. In all such cases, a comparison of the existing with the former state of mind, supplies a simple and obvious test, which seems to have been strangely overlooked by medical men, till the interesting case of Mr. Edward Davies gave Dr. Gooch the opportunity of pointing it out, and insisting upon its importance. (See 'Quarterly Review,' 1830, and the first edition of this work.)

The tests of capacity usually recommended in cases of imbecility are obviously insufficient to determine whether or not a man is capable of managing his own property. The arithmetical test, on which so much stress has been laid, is a test of knowledge, not of power. A man may be the best accountant in the world, but he may labour under a moral imbecility, and have so mean a sense of right, so childish a fancy, and so weak a will, that from infancy to age he may yield to every impulse, and gratify every whim without once counting the cost. A patient of our own, with whom we had been intimate for years, owed pence as a child, and pounds as a boy, and added debt to debt with each year that passed over his head, till at length a severe disappointment brought on a distinct attack of mania, of which a benevolent but extravagant mission, violent outbursts of passion, and fierce hatreds, arrangements to spend a year's income in a week, and the unfounded expectation of an immense fortune on the morrow, were constitnent parts. He carried with him to an asylum delusions enough to furnish a dozen madmen, and died in the firm conviction that he was the Saviour of mankind. In this case there was the cultivated and refined intellect of a man with more than the weakness of a child; but no test could have proved him incapable of managing himself and his affairs, save only the history of his life. (G.)

The criminal acts of persons of weak intellect are as strongly marked by folly as their daily words and actions. They have no

surer characters, and we no better test. But in this case, as in that of maniacs, the law insists upon the test of a knowledge of right and wrong, which is as insufficient in criminal, as the arithmetical test in civil cases. It is a test of knowledge, not of power; and the knowledge of right, and the power to act aright, are as distinct as science and art.

Of the Characters of Unsoundness of Mind from Excessive Activity.

In tracing the more prominent characters of this division, or, in other words, of mania, the term will be used in its most extended sense as applied to those cases (and they are the great majority) in which the intellect, the affections, and the passions, are jointly implicated, whether there be one delusion or many, or merely some one excited emotion or passion, the source of a thousand changing fancies. This inquiry will prepare the way for an examination of the plea of insanity in criminal cases—a subject of great interest and importance.

1. *In mania, consciousness, memory, and reason may remain intact, even in the midst of the most violent paroxysms.*—The doctrine that mania is in all cases primarily an emotional disease is quite consistent with this proposition. It is quite conceivable that the emotions and passions may be subject to the most violent excitement, constant or intermittent, and yet the patient retain the use of reason, a perfect consciousness of all the relations in which he stands towards others, and a vivid recollection of every occurrence in which he has borne a part. It is true that in the actual paroxysm of maniacal excitement, there can be neither time nor place for acts of comparison or processes of reasoning, and that even conscience may lose all restraining power; but that memory remains intact, even in the most violent maniacal outbursts, there is no room to doubt. We were consulted in the case of a lady who had been suffering from mania for many years, with frequent paroxysms of extreme violence; in one of which she had destroyed some valuable papers belonging to her husband; and yet after the lapse of twenty years, during an interval of tranquillity, she reverted to the occurrence, and expressed her regret at what had happened. We have found similar evidence of accurate recollection in the autobiographies and *viva-voce* histories of convalescents from mania. (G.)

Of the intact condition of the higher mental faculties in the maniac's more tranquil moments no medical evidence need be adduced. It will suffice to quote the words of Erskine, used at the trial of Hadfield for shooting at George III. in Drury Lane

Theatre in 1800. "In all the cases," he says, "which have filled Westminster Hall with the most complicated considerations, the lunatics, and other insane persons who have been the subjects of them, have not only had memory *in my sense of the expression*,—they have not only had the most perfect knowledge and recollection of all the relations they stood in towards others, and of the acts and circumstances of their lives, but have, in general, been remarkable for subtlety and acuteness. Defects in their reasoning have seldom been traceable,—the disease consisting in the delusive sources of thought,—all their deductions, within the scope of their malady, being founded on the *immoveable* assumption of matters as *realities*, either without any foundation whatever, or so distorted and disfigured by fancy, as to be nearly the same thing as their creation."

The madman, then, reasons like other men, with this difference, that his delusions being stronger than the imaginations of a sane man, and his passions more violent, reason is more readily made the advocate of the one and the slave of the other; and this is true of all the faculties of the mind, and even of the senses. His delusions are too strong even for them.

2. *The senses are deceived and confounded.*—The author of the autobiography referred to at p. 171, says:—"My senses were all mocked at and deceived. In reading, my eyes saw words on the paper, which, when I looked again, were not. The forms of those around me, and their features, changed even as I looked on them." "I heard the voices of invisible agents, and notes so divine, so pure, so holy, that they alone, perhaps, might recompense me for many sufferings. My sense of feeling was not the same; my smell, my taste, gone or confounded." The conversion of familiar sounds, such as the lowing of cattle, the falling of water, the grating of a chain, the noise of footsteps, into articulate speech, was not the least remarkable feature of this most interesting and instructive case. Illusions of sight and hearing, and illusive transformations of real sensations, are, it is well known, among the most general accompaniments of mania.

3. *The persons by whom the madman is surrounded derive their characters from his delusion.*—In the eyes of the author of the autobiography the inmates of the asylum and his keepers were supernatural beings. There was a maniac there whom his spirits called the Lord Jehovah, supremely omnipotent, the Trinity in unity; and he took one of the keepers to be the Saviour of mankind. These same persons underwent the strangest transformation, and according to the state of his mind, were either angels or fiends.

4. *Real impressions on the organs of sense become, as in dreams, the materials of imaginary scenes.*—This curious phenomenon, also, is strikingly illustrated in the autobiography. The cold air blows on him as he is trying to suffocate himself, in obedience to the spirits that speak within him: and he conjures up the spirits of his sisters cooling him with their breath, and encouraging him to go through with his task. The familiar sensation of water trickling down the back is converted into the crystal tears of his father, whose venerable countenance he sees bending over him. His shaven head suggests the painful notion that he has received the tonsure of the Roman Catholic priesthood, a mark of the beast. The flames in the grate become the utterance of his father's spirit, striving within him to save him, and obliged to return to hell-fire, to be purified from the contamination of his foul thoughts. The lowing of the cattle conveys to him articulate sounds and sentences, and the grating of the chair against the wall speaks to him in his father's voice.

5. *The strange antics of the madman are the effects of his delusion.*—The following passages from the autobiography fully establish this proposition: "I expected to be guided to prayer; but a spirit guided me, and placed me in a chair, in a constrained position, with my head turned to look at the clock, the hand of which I saw proceeding to the first quarter; I understood I was to leave the position when it came to the quarter." "Another delusion I laboured under was, that I should keep my head and heart together, and so serve the Lord, by throwing myself head over heels over every stile or gate I came to; the condition here was, as before, on its being done in *precision and decision*." A keeper, in struggling with a patient, throws him down and nearly strangles him. "When I saw his bloated and inflamed cheeks, and the eyes starting out of the sockets, I offered to do anything to rescue him. My spirits desired me to whirl myself round and round as fast as I could, which I did till I staggered against the wall, and nearly fell on the stone pavement." This last quotation suggests the corollary that

6. *The madman's acts, the results of his delusions, are such as no sane man would believe fitted to compass the object in view.*

7. *The violence of the madman is often the effect not of mere passion but of his delusion.*—"I knew no malice," says the author of the autobiography, "no vice. I imagined that they (the keepers) loved me, and were all deeply interested in the salvation of my soul, and I imagined, too, that I loved them dearly. Yet I wrestled with the keepers, and offered to do so with others, and struck many hard blows; sometimes, as one informed me,

making it difficult for three strong men to control me; yet whenever I did this, I was commanded, that they wished me to do so, to prove my faith and courage, but that they were commanded to prove both till they were satisfied of my sincerity." "It was always a great delight to me to get my hand at liberty, even for a moment, and the first use I usually made of it was to strike the keeper who untied me; directed by my spirits to do so, as the return he desired above all things else, because he knew I was proving my gratitude to the Lord Jehovah at the risk of being struck myself." Doubtless the keepers regarded this as mere senseless and motiveless violence. Do we not equally misunderstand the criminal acts of the lunatic?*

8. *The maniac, if of a reserved disposition, or when impelled by a strong motive, can conceal his delusion.*—The proof of this proposition may be found in every work on insanity; and a remarkable illustration of it was given by Erskine in his defence of Hadfield. A person who had been confined in an asylum prosecuted his brother and the proprietor for imprisonment and false duress: Erskine was told that the man was undoubtedly insane; but not told the particular form which the malady assumed. The prosecutor, himself a witness in support of the indictment, was put into the witness-box and examined; and when Erskine came to cross-examine him, he found his evidence clear, distinct, collected, and rational. He tried to discover some lurking alienation of mind; but during a cross-examination, conducted with all the skill and sagacity of which he was master, for nearly an hour, he was completely foiled: the answers were perfectly rational—there was not the slightest appearance of mental alienation. But a gentleman who had been accidentally detained, came into court, and whispered in Erskine's ear that the witness thought he was the Saviour of mankind. On receiving the hint, Erskine made a low bow to the witness, addressed him in terms of great reverence, respectfully begged to apologize for the unceremonious manner in which he had treated a person of his sacred character, and called him by the name of Christ. The man immediately said, "Thou hast spoken truly: I am the Christ!" Pinel relates a similar case. A commission appointed to visit the Bicêtre, examined one particular patient repeatedly on many successive days; but all their endeavours to prove him insane failed. They accordingly ordered a certificate to be prepared for his release; and placed it before him for his

* These statements, like others in this instructive autobiography, are singularly in keeping with those of a recovered religious maniac who was for a long period under our *observation*. *(G.)*

signature. He signed "Jesus Christ." In a case to which we have already referred (p. 203), we have reason to believe that more than one of the patient's delusions was never mentioned to any one but ourselves, and that only once; nor could he be induced by long conversations framed for the purpose to give the slightest indication of them to third parties. And a lady who, among other delusions, believed herself Queen of England, spoke on the subject only to one of her sisters; so that it was only by listening at the open door that we could obtain evidence of the fact. (G.)

9. *The acts of the maniac often evince the same forethought and preparation as those of the sane.*—A patient confined in the Manchester Lunatic Asylum, had been cruelly treated by a keeper, and in revenge killed him. He related the particulars of the transaction to Dr. Haslam with great calmness and self-possession. He said: "The man whom I stabbed richly deserved it. He behaved to me with great violence and cruelty; he degraded my nature as a human being; he tied me down, handcuffed me, and confined my hands much higher than my head, with a leathern thong; he stretched me on the bed of torture; after some days he released me. I gave him warning; for I told his wife I would have justice of him. On her communicating this to him, he came to me in a furious passion, threw me down, dragged me through the court-yard, thumped me on my breast, and confined me in a dark and damp cell. Not liking this situation, I was induced to play the hypocrite. I pretended extreme sorrow for having threatened him, and, by an affectation of repentance, prevailed on him to release me. For several days I paid him great attention, and lent him every assistance. He seemed much pleased with the flattery, and became very friendly in his behaviour towards me. Going one day into the kitchen, where his wife was busied, I saw a knife; this was too great a temptation to be resisted: I concealed it about my person, and carried it with me. For some time afterwards, the same friendly intercourse was maintained between us; but as he was one day unlocking his garden door, I seized the opportunity, and plunged the knife up to the hilt in his back."

10. *The maniac, in spite of his proverbial cunning, is easily imposed upon.*—Of this, which forms the great safeguard of the sane in their dealings with maniacs, a good illustration is contained in Lockhart's 'Life of Sir Walter Scott.' Henry Weber, Scott's protégé and amanuensis, had been reproved by him for indulging in habits of intoxication, which injured his health and interfered with his literary pursuits. On the evening after his

return from Edinburgh, Scott observed Weber's eye fixed upon him with an unusual solemnity of expression. On inquiring after his health, Weber rose and said: "Mr. Scott, you have long insulted me, and I can bear it no longer. I have brought a pair of pistols with me, and must insist on your taking one of them instantly;" and with that he produced the weapons, which had been deposited under his chair, and laid one of them on Scott's manuscript. "You are mistaken, I think," said Scott, "in your way of setting about this affair—but no matter. It can, however, be no part of your object to annoy Mrs. Scott and the children; therefore, if you please, we will put the pistols into the drawer till after dinner, and then arrange to go out together like gentlemen." Weber answered with equal coolness, "I believe that will be better," and laid the second pistol also on the table. Scott locked them both in his desk, and said: "I am glad you have felt the propriety of what I suggested—let me only request further that nothing may occur while we are at dinner to give my wife any suspicion of what has been passing." Weber again assented, and Scott withdrew to his dressing-room, despatched a message to one of Weber's intimate companions, and had the maniac secured and placed in confinement.

11. *Maniacs in confinement are often conscious of their state, and know the legal relations in which it places them.*—An intriguing, unruly, vicious madman was detected with a piece of iron, which he had contrived to shape like a dagger, and fix in a handle. When the weapon was taken from him, he became excessively abusive, and had to be placed under restraint. In the fit of fury that followed, he uttered the most revolting imprecations, and exclaimed to the keeper, "*I'll murder you yet; I am a madman, and they cannot hang me for it.*" When Martin set fire to York Minster, the inmates of a neighbouring madhouse discussed the question whether Martin would suffer the extreme penalty of the law. Various opinions were expressed; but one patient, apparently as mad as the rest, exclaimed, "He (Martin) will not be hanged—of course he will escape." "For what reason?" asked several voices. "They cannot hang him," replied the lunatic, "because he is mad,—*he is one of ourselves!*"* It is important to understand that this consciousness of their state belongs only to madmen surrounded by madmen in lunatic asylums, or to those who have been under treatment.

The foregoing are some of those leading characters of mania which bear on the decision of medico-legal questions. They serve

* Winslow's 'Plea of Insanity in Criminal Cases,' pp. 16, 17.

to throw light upon the phenomena of insanity, and to answer some of the arguments advanced by persons ignorant of the real nature of this strange condition of mind.* To the better informed they may be useful by setting forth more clearly than any general description could do, the contradictions of which the madman is the sport. It is probably beyond the power of the sane mind to conceive the confusion which reigns in the mind of the madman. A series of delusions, the offspring of some one excited passion or emotion, or one single delusion, the work of fancy, the interpreter of every sensation, the source of every thought, the mainspring of every action; holding every faculty in stern subjection, making the senses its dupes, the reason its advocate, the fancy its sport, the will its slave; now whispering in the ear things un-spoken, now painting on the eye things unseen; changing human beings at will into fiends or angels; converting every sensation into a vision, every sound into articulate speech; the unreal world within in constant conflict with the real world without; understood of no one, yet believing himself to be comprehended by all; punished for the very acts which he believes his tyrants to have commanded, controlled in everything which he thinks it his duty to perform. There is no wish however presumptuous, no fancy however monstrous, no action however absurd, no crime however heinous, that his delusion cannot create, prompt, and justify.

The degree of confusion existing in the mind of the madman will, of course, vary with the nature and extent of his delusions. When several spring from one excited emotion or passion, such as pride, vanity, or religious veneration, the distraction must be greater than when one single delusion takes possession of the mind.

Legal relations of Mania.—There is a difference between the effect of mania on civil and criminal acts.

In all civil matters, if a man can be shown "to be *non compos mentis*, the law avoids his act, though it cannot be traced to, or connected with the morbid imagination which constitutes his disease, and which may be extremely partial in its influence on conduct."† In reference to testamentary capacity, however, the administration of the law is modified according as the individual in question is the subject of general mental aberration or only of partial insanity—monomania. In the former case little or no difficulty is experienced. In the latter, however, decisions in several

* For a very able exposition of some of the characters of mania, see Abercrombie, 'On the Intellectual Powers,' 9th edition, pp. 215 and 226.

† Erskine, in his defence of Hadfield also the judgment of Sir James Wilde in the case of Mrs. Thwaites, August, 1867.

recent cases distinctly recognise the fact, that the individual is considered quite capable of making a will, unless he is shown to have laboured under a delusion which would materially influence his deposition.

In the case of "Banks *v.* Goodfellow,"* in which the question arose whether a delusion not directly calculated to influence the disposition of property should be considered to invalidate the will, Cockburn, C. J., said—"We are of opinion that a jury should be told that the existence of a delusion compatible with the retention of the general powers of the faculties of the mind will not be sufficient to overthrow the will, unless it was calculated to influence the testator in making it."

Partial intellectual insanity, therefore, need not, according to the law, deprive a man of his civil capacity as far as regards his power to make a will. In other cases, however, the capacity is apparently not recognised.

But in criminal cases it is not enough to prove a man *non compos mentis;* he is liable to punishment for transgressions of the law, unless it can be shown that he is insane according to what the law chooses to lay down as a practical test of insanity.

Of late years a perpetual conflict has existed between the legal and medical profession on the subject of the plea of insanity in criminal cases; the law being unwilling to recognise the teachings of modern medical psychology as tending to subvert the doctrine of moral responsibility, and defeat the object the law has in view —viz., to deter from crime. In their endeavours to establish a test of insanity, medical psychologists have not always in disputed cases expressed their views with that degree of unanimity which would justify a radical revision of the existing legal test, nor have they taken into account the difficulty which the law, as a practical science, experiences in laying down rules which will in all cases conform to the strictly scientific view. Medical men will not undertake to define the terms sanity and insanity. An abrupt line of demarcation does not exist. Yet the law must adopt some standard by which to determine the existence or not of responsibility.

To frame a standard of moral responsibility which shall at the same time satisfy the requirements of an enlightened psychology, and yet not weaken the influence of the law in its main object, the prevention of crime and protection of society, is a task of no ordinary difficulty. So much so, that many have contended that no such test is possible, and that each case should be decided on its own merits and on the opinions of psychological experts.

* *Law Rep.*, vol. v. Q. B. 549.

This proposition is obviously out of the question when it comes to practical application.

The difficulty which the law itself has experienced in adapting its requirements to the progressive knowledge of the true nature of mental unsoundness, and of its many forms and varieties, is well shown in the modifications which have taken place in the legal tests of insanity.

The plea of Insanity in criminal cases.—It is necessary to premise that the plea of insanity may be raised in respect of such grave offences as homicide, arson, and theft, but as the large majority have been cases of homicide, and almost all the legal discussions of importance have arisen out of them, the remarks that follow must be understood to relate primarily to homicide. It should also be borne in mind that though the plea of insanity may be set up in reference to homicidal acts committed in a maniacal paroxysm, and by persons otherwise rational alleged to be seized with an uncontrollable impulse, the greater number of cases belong to the class of mania with delusion in which the homicidal act has been carefully planned, and carried deliberately into effect.

Our earliest legal authorities evidently confounded mania with idiocy, for Bracton defines a madman as one who "does not understand what he is doing, and, wanting mind and reason, differs little from brutes;" and when the attorney-general, on the trial of Hadfield, in the first year of this century, laid down the law, "that to protect a man from criminal responsibility there must be a *total* deprivation of memory and understanding," Erskine admitted this to be "the very expression used both by Lord Coke and by Lord Hale," and though Lord Hale made a slight step in advance by distinguishing *total* from *partial* insanity, alleging that partial insanity was no excuse in the commission of any capital offence, and suggesting as a measure of responsibility, "that such a person as, labouring under melancholy distempers, hath yet as great understanding as ordinarily a child of fourteen years hath, is such a person as can be guilty of treason and felony," we find Mr. Justice Tracy, in the trial of Arnold, in 1723, for shooting at Lord Onslow, still under the guidance of Bracton, and observing: "It is not every kind of frantic humour, or something unaccountable in a man's actions, that points him out to be such a madman as is exempted from punishment: it must be a man that is totally deprived of his understanding and memory, and doth not know what he is doing, no more than an infant, than a brute, or a wild beast: such a one is never the object of punishment."

The trial of Hadfield gave the death-blow to these narrow and unsound doctrines, and established delusion as the true test of intellectual mania. In conducting the defence, Erskine showed that what the law had styled madness was idiocy—the idiocy *à nativitate vel dementia naturalis* of Lord Hale himself—and that no such madness as that imagined by the older writers had "ever existed in the world." He then succeeded in showing that "delusion, when there is no frenzy or raving madness, is the true character of insanity," but added the very questionable proviso that in order to render the madman irresponsible for crime, it must be shown, that the act in question was the immediate unqualified offspring of the disease.

These new doctrines, though always quoted with approbation, were soon lost sight of, and in place of the test of delusion, sprang up that of "right and wrong." Thus, in the case of Bellingham tried at the Old Bailey for the murder of Mr. Perceval, May 15, 1812, Mansfield, C. J., is reported to have told the jury that they must be satisfied, in order to acquit, that the prisoner was incapable of judging between right and wrong, and that at the time of committing the atrocious act with which he stood charged, he did not consider that murder was a crime against the laws of *God and Nature*. In a case which occurred only two months later (that of Bowler for shooting Mr. Burrowes), Mr. Justice Le Blanc left it to the jury to determine whether the prisoner, when he committed the offence, was incapable of distinguishing between right and wrong, or whether he was under any illusion in respect to the person he shot, which rendered his mind at the time insensible to the nature of the act he was about to commit; since in that case he would not be legally responsible for his conduct. In a still more recent case (Rex *v.* Offord), Lord Lyndhurst told the jury to acquit, if they were satisfied that the prisoner did not consider his act any crime against the laws of *God and Nature*. A similar principle, with slight and unimportant verbal variations, was affirmed in the trial of Oxford for firing at the Queen, and in the case of M'Naughten, which led to an able exposition of the law by the lord chancellor in the House of Lords, and elicited the opinions of the law lords, and carefully considered answers to certain questions addressed to the judges.

The state of the law up to a recent date, and, indeed, up to the present time, may be inferred from the answers of the fifteen judges to the questions suggested by the trial of M'Naughten, and submitted to them by the House of Lords. The answers, in which the whole bench, with the exception of Mr. Justice Maule, concurred, were read to the House by Lord Chief Justice Tindal

on the 19th June, 1843. They are given *in extenso* below,* and it will be seen from them that before the plea of insanity can be allowed, it must be proved in evidence that the accused was of diseased mind, and that at the time of committing the act he was not conscious of right and wrong; that though delusion be taken

* Question I. What is the law respecting alleged crimes committed by persons afflicted with insane delusion, in respect of one or more particular subjects or persons: as, for instance, where at the time of the commission of the alleged crime the accused knew he was acting contrary to law, but did the act coupled with the view, under the influence of some insane delusion, of redressing or avenging some supposed grievance or injury, or of producing some supposed public benefit? —Answer. *The opinion of the judges was, that, notwithstanding the party committed a wrong act, while labouring under the idea that he was redressing a supposed grievance or injury, or under the impression of obtaining some public or private benefit, he was liable to punishment.*

Question II. What are the proper questions to be submitted to the jury, when a person alleged to be affected with insane delusion, respecting one or more particular subjects or persons, is charged with the commission of a crime (murder, for example) and insanity is set up as a defence? Answer. The jury ought in all cases to be told that every man should be considered of sane mind until the contrary were clearly proved in evidence. That before a plea of insanity should be allowed, undoubted evidence ought to be adduced *that the accused was of diseased mind, and that at the time he committed the act he was not conscious of right and wrong.* This opinion related to every case in which a party was charged with an illegal act, and a plea of insanity was set up. *Every person was supposed to know what the law was, and therefore nothing could justify a wrong act except it was clearly proved that the party did not know right from wrong.* If that was not satisfactorily proved, the accused was liable to punishment, and it was the duty of the judge so to tell the jury when summing up the evidence, accompanied by those remarks and observations which the nature and peculiarities of each case might suggest and require.

Question III. In what terms ought the question to be left to the jury as to the prisoner's state of mind at the time when the act was committed? No answer.

Question IV. If a person, under an insane delusion as to existing facts, commits an offence in consequence thereof, is he hereby excused?—Answer. *If the delusion were only partial, the party accused was equally liable with a person of sane mind. If the accused killed another in self-defence, he would be entitled to an acquittal; but if the crime were committed for any supposed injury, he would then be liable to the punishment awarded by the laws to his crime.*

Question V. Can a medical man, conversant with the disease of insanity, who never saw the prisoner previously to the trial, but who was present during the whole trial and the examination of all the witnesses, be asked his opinion as to the state of the prisoner's mind at the time of the commission of the alleged crime, or his opinion whether the prisoner was conscious, at the time of doing the act, that he was acting contrary to law? or whether he was labouring under any, and what delusion at the time? —Answer. The question could not be put in the precise form stated above, for by doing so it would be assumed that the facts had been proved. When the facts were proved and admitted, then the question as one of science would be generally put to a witness under the circumstances stated in the interrogatory.

Mr Justice Maule dissented from the answer to this last question. In his opinion such questions might be at once put to medical men without reference to the facts proved, and he considered that this had been done, and the legality of the practice thereby confirmed on the trial of M'Naughten.

as the test of insanity, the knowledge of right and wrong is taken as the criterion of responsibility.

To make delusion the sole legal test of insanity in criminal cases, and especially in cases of homicide, is completely at variance with the well ascertained facts of impulsive insanity, in which the existence of delusion can be distinctly negatived, as well as in many forms of emotional insanity, in which delusions form no necessary feature of the disease.

On the other hand, it appears at first sight very absurd to make the knowledge of right and wrong the test of responsibility; for a great many insane patients have a clear appreciation of the two ideas. Indeed, the whole management of asylums presupposes a knowledge of right and wrong on the part of the inmates.

There is, however, a vast difference between a speculative knowledge of right and wrong and the power to act accordingly; for a man may be fully convinced of the criminality of an act, and yet be unable to refrain from committing it. From some vague instinctive impulse springing from within, or more frequently set in motion by some external stimulus (just as a muscle is made to contract by reflex action), he may be impelled to commit an act of homicide; and yet before this instinctive impulse arose, and, as frequently happens, after the act has been committed, he may have as lively a sense of the criminality of the act, and of the general notions of right and wrong, as any perfectly sane man. So again a man may have a general sense of right and wrong, and yet be impelled by some delusion, such as a supernatural voice, to commit some crime. In this case the knowledge of right and wrong has no existence in reference to this deed.

The mere knowledge of right and wrong must therefore be regarded as a defective and unsatisfactory test. Mr. Balfour Browne* has ingeniously pointed out that the legal test has been much misapprehended, and he suggests a way in which the difficulty may in some measure be got over. He says:—"The words of the Judges' answer are these: 'That before a plea of insanity should be allowed, undoubted evidence ought to be adduced that the accused was of diseased mind, and that *at the time* he committed the act he was not conscious of right and wrong.'" I think that any one who reads these words will be convinced that it is not the knowledge of right and wrong which one may speculatively entertain in calm moments which is meant to be the test of insanity, as so many persons seem to imagine, but that it is the active idea of right and wrong which a man has

* 'Responsibility and Disease,' p. 40.

when thought is passing over into action that is relied upon as the distinguishing mark of sanity. These words do not mean that a man's responsibility is to be judged of by his thorough understanding of the Decalogue, or by his calm doubts as to the existence of a conscience. They mean that we are to judge by means of the principle of action; and I am so far from thinking that it is the intention of the law to make a speculative belief the test of insanity, that I regard these words as indicating an intention to make the capacity of doing or refraining, the power of choice between good and evil, the real test, and that it shows that such is its intention by the words, "at the time he committed the act."

This view of the legal test certainly disposes of many objections. For in this way the existence of a delusion impelling a man to commit a crime is regarded as subverting all moral distinctions at the time, and in the cases of impulsive insanity the defective power of choice, whatever the speculative opinions might be, would be allowed to establish the fact of irresponsibility. Practically in courts of law the great majority of cases have been decided according to this interpretation of the test, notwithstanding the numerous conflicts of opinion between the medical and legal profession as to its real value or meaning.

There is one other point of great importance in the Judges' answers as quoted above, which relates to the responsibility of the partially insane. It is there laid down that an individual who is only partially insane is equally responsible for a crime as a person of sane mind. In so far as the act would be excused in a sane person, as, for instance, homicide in self-defence, the monomaniac would be excused, but not if the act were committed in revenge for some supposed injury.

Nothing can be more illogical than the law so stated; for it amounts to nothing less than an absolute denial of the significance of a state of things which has already been acknowledged to constitute a valid test of insanity. It is true that a maniac subject to a great number of delusions must be less able to control his irregular impulses than one who has but one or two; for a multitude of delusions naturally implies more confusion and more excitement. Single delusions are doubtless more compatible with self-restraint; but they are of rare occurrence, and do not often figure in courts of law. *Partial delusions* are much more common, but when they are closely examined they are found to be the offspring and natural expression of some one excited feeling or passion, which, having had force enough to create illusions of the senses and

delusions of the mind, may be expected to give rise to insane impulses of great power.

The excited feelings or passions which, having first destroyed the integrity of the senses and mental faculties, proceed to instigate acts of violence and cruelty, are religious excitement or despondency; jealousy; domestic anxieties exaggerated into fear of starvation; and discontent transformed into an insane belief in persecution. Now the acts of violence which ultimately flow from these excited feelings or passions, after they have given rise to a series of delusive ideas, ought to be judged by the same rules which apply to the delusions themselves. The acts are probably as little subject to restraint as the delusions to correction.

We will consider these four sources of homicidal acts separately.

Maniacs under the influence of religious excitement or despondency are subject to illusions and delusions of a very singular kind. They transform the persons with whom they are associated into supernatural beings, endowed with authority or power not to be questioned or resisted; and they convert common and familiar sounds into the articulate language of temptation or command. One religious maniac, therefore, kills a relative or a keeper, imagining him to be a fiend; another thinks that he has a direct commission from the Deity to fulfil some mission of wrath or extirpation. In cases of religious mania, then, we can never safely affirm that the homicidal act was not the natural consequence of a command which the maniac would deem it impious to resist, or of a delusion which places him in his own sincere conviction beyond and above the operation of human laws. The maniac who believes himself to be God, Christ, or the Holy Ghost, would, from the very nature of the case, deem himself irresponsible.

Of homicidal acts instigated by jealousy shaping itself into a distinct delusion it will suffice to observe that they are such acts as if committed by sane men on the evidence of their senses would be punished as manslaughter, and not as murder.

Of the fathers and mothers who kill their children under the pressure of domestic anxiety culminating in an insane dread of starvation, it may be observed that they are generally remarkable for domestic virtue and devoted attachment to their victims, and that between them and ordinary murderers there is no single point of resemblance.

Discontent, transformed into an insane belief in persecution, presents greater difficulties. The case is generally put in a form

which seems to preclude a satisfactory answer. A maniac believes himself to have been injured by another, and he kills him. If the injury were real, the murderer would be responsible, and so, it is contended, ought the madman to be. This curiously illogical argument ignores the simple fact that the two cases have nothing in common but the act itself. The imaginary offence has imaginary accompaniments, and every thought connected with it is one of confusion To suppose that a mind which can imagine an impossible offence is sound in all other respects is to outrage common sense, and set at nought the experience of all who have knowledge of the insane, who with one consent repudiate the notion of a mind subject to such a delusion being sound, and free to act as it will, beyond the sphere of its influence. The more closely the victim of this partial delusion is observed, the more extensive is found to be the disorder of his intellect. His actions which are not directly prompted by his delusion are more strange, and his passions more excitable than those of other men. The theory of a single insane idea, unaccompanied by any other disordered action of the faculty from which it takes its rise, having no effect on the remaining faculties, and showing itself simply by prompting an action which, once suggested, is carried out with the same complete consciousness of its real nature as exists in the mind of a sane man acting under the suggestion of a corresponding reality, is too absurd to be for a moment entertained. Even in this case, then, the question of responsibility cannot be decided by the simple test of a knowledge of right and wrong.

But there is another case allied to the one now under consideration which presents still greater difficulties. A man receives a real injury, and avenges himself; but it is alleged that he was not of sound mind when he committed the act. The unsoundness of his mind is admitted, but he is deemed responsible because he was instigated by the common motive of revenge. The obvious answer is, that the real injury has been by his insane mind magnified to undue importance, and then acted upon just as if it had been altogether imaginary; and that he is therefore neither more nor less responsible for his act than the man whose motive was from the very first in the nature of a delusion. In this case, too, an inquiry into the state of the mind, extending much beyond the legal test, will be necessary, and cannot be refused; and this, once granted, must result in showing the insufficiency of the test. Even in those cases where the criminal act cannot be traced to any delusion of which it is the legitimate *offspring*, but it is simply alleged in defence that the party is of

unsound mind, the very fact of the unsoundness becomes an irresistible plea in mitigation. It would be strange, indeed, if the case of the maniac under the accusation of crime were the only one in which such a plea is ignored and refused.

It is eminently absurd to credit a mind which is already occupied by delusions with an otherwise efficient state of its faculties. It is in the highest degree improbable that a mind so possessed is able, beyond the sphere of its delusions, to think, feel, and act with the clearness, force, and freedom of the sane. And though the aberration may for a time remain confined within a limited sphere, it is always very uncertain whether it will not ultimately pervert the whole of the mental faculties. For many practical purposes it may be well to recognise the sanity of the individual in other respects; but great injustice would be done if the law took no cognizance of the uncertain condition of the mind subject to partial delusions. Theoretically the law does not, but practically it does recognise it in its decisions; for it shows itself in such cases more ready to accept the plea of insanity than in those where insanity had not before been shown to exist. The legal tests of insanity are therefore subject to grave objections in many particulars; but considering the difficulty of laying down any rules which shall be consistent at once with the data of science and practically applicable, great allowances must be made; and until medical psychologists have themselves arrived at a standard which shall draw a sharp line between responsibility and irresponsibility, law, as a practical science, must adopt a standard of responsibility by which cases may be tried. That the present is in many respects unsatisfactory must be admitted, but it is easier to raise objections than remedy them.

Some writers, under a strong sense of the failure of the legal test of a knowledge of right and wrong, have sought to set up in its place the power of control or restraint. The test has been thus transferred from the intellect to the will—from the knowledge of right to the power of acting aright. But this is a mere shifting of the difficulty; for it is obviously not more easy to ascertain a man's abstract knowledge of right and wrong, lawful and unlawful, than to measure the exact amount of his self-restraint.

This test appears, indeed, to have one advantage over the knowledge of right and wrong. The very mode of accomplishing the homicidal act seems to supply a measure of the amount of restraint or self-control which the maniac is able to exert. If he watches his opportunity, bides his time, prepares a fitting instrument, and uses it in the ordinary way, it is inferred that he

possessed such an amount of self-control as ought to have prevented the murderous act. But the answer is obvious. It is drawn from the analogy of the madman's sensations and thoughts. If he could not prevent the senses from being the sport of illusions, and was unable to root out delusions from his mind, it is not to be supposed that he can control the irregular impulses and passions which are to the will what illusions are to the senses or delusions to the intellect. And if it be alleged that the skill evinced in planning the homicidal act, and the patience shown in waiting for a favourable opportunity, ought to be taken as evidence of adequate self control, appeal may again be made to analogy. The acts of the maniac are in strict keeping with his thoughts. His delusions, even when they are most distinctly present to his mind, are quite compatible with the exercise of all his faculties. If they are attacked, he defends them acutely, and justifies them plausibly. They have not destroyed his faculties, they have merely perverted them to a wrong use. So is it with his homicidal act. The impulse which seizes upon his unsound mind does not destroy its powers, it merely perverts them.

Accordingly, if a maniac is under the delusion that his keeper is a fiend, or if he believes that the Deity has commissioned him to take away his life, he will secrete and sharpen a knife, watch his opportunity, and act in every respect as a sane criminal would do. And, if prevented, he will wait for a more favourable occasion. Nay, the merest imbecile knows that a knife or a pistol is a common instrument of death; and weak as his mind may be, he conceals his weapon, not because he is conscious of guilt, but because he knows that, if it were openly displayed, the action he contemplates would be prevented. The fact is, that in proposing this test, as in the general discussion of this question, two distinct things have been confounded—the act itself, which is the result of the delusion, and the mode of accomplishing it. It is the delusion which distinguishes the madman, and not the mode in which the delusive impulse is carried into effect.

The difficulty of devising a test which shall not be open to the most serious objections, has led some persons to invent an easy method of escape, by depriving persons of unsound mind of what they call the privilege of insanity, or, in other words, refusing to entertain the question of the state of the mind at all. This suggestion may have the merit of simplicity, but it is open to the serious objection that it could be acted upon only once. The spectacle of a madman on the scaffold would be simply intolerable. No jury could be found to convict; and the indiscriminating statute would prove as complete a dead letter as the statute which

awards the punishment of flogging to assaults upon the Queen did, when it was to be applied to the person of poor Lieutenant Pate. The idea of hanging and flogging madmen is utterly repulsive, and must be given up.

Another theory propounded by some writers of eminence, is that as madmen are, like other men, influenced by fear, the punishment of death as the consequence of murder, should be kept before their eyes. This theory may be said to have broken down in the case of Lieutenant Pate, just referred to. It is most improbable that this poor imbecile was ignorant of the degrading punishment awarded by a recent statute to persons who should assault the sovereign; but the threat had no effect upon him. By parity of reasoning, it seems most probable that the threatened punishment of death would prove equally ineffectual in every class of madmen. But, in reality, the restraining influence of the punishment of death is already brought to bear; for it should be borne in mind that men who have not been certified as insane, and confined in lunatic asylums, do not believe themselves to be mad. They are, in their own sight, sane men. It is only after men have been taught, by confinement as madmen, that they are insane, or are believed to be so, that the terror of the gallows is replaced by the alternative terror of perpetual imprisonment.

Those who maintain the theory now under examination are apt to defend it by comparing persons of unsound mind with the lower animals, alleging that, as dogs can be weaned by punishment from practices distasteful to their masters, so madmen can be deterred from crime by fear of death.

In putting forward this argument from analogy two facts are overlooked—the fact that the animal has been punished, and has a distinct recollection of the pain inflicted upon him, while the madman has been merely threatened; and the fact that there are many dogs who cannot be weaned from bad habits by the frequent repetition of the most severe chastisement.

It is reasonable to add, that if we assume the madman to be attentive to, and cognizant of, what is being said and done by the public, he must know that a verdict of acquittal, on the ground of insanity, brings with it, as a necessary consequence, confinement for life, which, were it inflicted as a punishment, would not be second in severity even to death itself.

Nor is there any good reason to fear that, by exempting the madman from the punishment of death, we shall weaken the hold which the law has on the man of sound mind; for in order that he may escape death, he must successfully feign insanity—a task of no ordinary difficulty—and, if he succeed, a perpetual sacrifice of

liberty awaits him. It is not likely, therefore, that society would suffer any injury by the adoption of the course presently to be advocated; and we may, perhaps, find that it gains something by openly attributing to disease some of the most revolting acts which degrade and debase our common nature.

Since the last edition of this work was published, namely, in 1868, I have submitted to the ordeal of fact the important question on the solution of which the retention of the plea of insanity may be said to turn, whether the admission of the plea and the consequent acquittal of notorious homicides tends in any way or degree to the encouragement of crime. The answer is distinctly in the negative: for "on testing the trials which have excited most public interest, and led to most discussion," namely, those of M'Naughten and Dadd, and Martha Brixey, of Oxford, and the equally notorious, though different cases of Francis, and Lieutenant Pate, "by the figures which represent either insane homicides or sane murderers in the year or years immediately following, there are no signs of encouragement when the penalty of death is not inflicted, or of discouragement when it is:—that on the contrary, the figures would seem to justify the inference that neither to the sane nor to the insane class among our criminals does the prospect of long imprisonment, or detention for life in a lunatic asylum, offer any attraction or temptation; while the punishment of death (perhaps only as formerly inflicted) seems as if it might have exercised a certain attraction or fascination."*

In respect to the responsibility of madmen, then, the law seems to be in this dilemma;—it must either insist upon a test which it is impossible to apply, or it must uniformly refuse or admit the plea of insanity. If it hold to a test, its decisions will want that uniformity which ought to belong to them, and their soundness will be constantly liable to be called in question; if it reject the plea of insanity, it ought forthwith to do away with all other pleas in mitigation.

In the case, then, of the class of maniacs now under consideration, who, being subject to delusion, commit their acts of violence with premeditation, it is submitted that all the legal and moral tests are inapplicable and useless; and that the law of England ought to be assimilated to that of France—"Il n'y a ni crime ni délit lorsque le prévenu était en état de démence au temps de l'action."

The foregoing observations apply to those cases only in which

* 'On Insanity and Crime; and on the Plea of Insanity in Criminal Cases.' *By William A. Guy, M.B., F.R.S., &c. &c.* 'Journal of the Statistical Society,' vol. xxxii p. 189 (April, 1869).

distinct proof has been obtained of unsoundness of mind, existing previously, as well as at the very time of the criminal act, and not to that instinctive madness which is altogether independent of the intellect, and consists merely in uncontrollable impulse.

This form of madness is now generally recognised by medical men as *instinctive* or *impulsive* mania, and has on more than one occasion led to the acquittal of an accused party.

The criminal acts committed under its influence have most or all of the following characters: They are without discoverable motive, or in opposition to all known motives. A man kills his wife, to whom he is tenderly attached; a brother his sister; a mother her infant; or the victim is one whom the madman never saw before in the course of his life, and against whom it is impossible that he can bear any malice. After the commission of the act, he does not seek to escape; he often publishes what he has done; does not conceal the body from view, but openly exposes it; delivers himself up to justice; describes the state of mind which led to the act, and either remains stupid and indifferent, or is overwhelmed by remorse. He has no accomplices, has made no preparations, and takes nothing from his victim. Sometimes he has previously spoken of his strong temptation, and begged to be prevented from doing mischief. These homicidal acts are generally preceded by a striking change of conduct and character, and, on inquiry, the accused is often found to have an hereditary tendency to insanity, to have attempted suicide, to have expressed a wish for death, or to be executed as a criminal. In this class of cases, it is most important that all the facts should be duly weighed, and careful search made after those motives which most frequently actuate the criminal.

It is in such difficult cases, too, that a caution is especially necessary against basing a decision upon one or two alleged characteristics. All the circumstances of the act ought to be duly weighed, in the spirit of the words of Lord Hale: "lest, on the one side, there be a kind of inhumanity towards the defects of human nature, or, on the other side, too great an indulgence given to great crimes." This instinctive madness is no doubt sometimes associated with delusions, the criminal act itself being the result of strong excitement of the passions, while the delusions suggest the motive. To this class probably belong those cases of wholesale murder in which the father of a family destroys his wife and children, to prevent them from falling victims to starvation, and then puts an end to his own life; the idea that such an evil threatens them being insane, no less than the impulse which prompts such a mode of escape.

Violent homicidal impulses are very common in the *epileptic*, sometimes preceding, sometimes following the paroxysms, and sometimes also taking their place, in which latter case the attack is described as *masked epilepsy*. The following cases are instructive.—

A shoemaker, subject to epilepsy, was often furious for some time after the fits, but sensible, amiable, and industrious in the intervals. One day, when in the gloomy and morose state of mind that often precedes a fit, he met the superintendent of the asylum, to whom he was much attached, and stabbed him to the heart. He had not had a fit for three weeks, but the night following the homicide he had a severe fit, and for some time the attacks continued to be frequent and severe.

A peasant suffered from epilepsy from his eighth to his twenty-fifth year, when, instead of epileptic attacks, he was seized with an irresistible impulse to kill. He felt the approach of his attack sometimes for days beforehand, and begged to be restrained. "When it seizes me," he said, "I must kill some one, were it only a child." Before the attack he was very weary and depressed, could not sleep, and had slight convulsions of the limbs.*

In order to complete this inquiry into the plea of insanity in criminal cases, the following sketch of the different aspects given to homicidal acts by the several varieties of unsound mind is submitted:—An imbecile has a confused and imperfect notion of crimes, laws, and punishments; and his acts are as foolish as his thoughts. The case referred to at p. 185 is a good example of this class. A monomaniac fancies himself an object of persecution, and he kills one of his imaginary tormentors, hoping thereby to rid himself of all; an act as mad as the thought which inspired it. Such was M'Naughten. Another, having betrayed decided symptoms of madness, receives a real injury and kills the offender. Such was Lord Ferrers. A third, oppressed with melancholy fears, kills those to whom he is most attached, to save them from some imaginary fate. Such was the female already referred to, who, under the fear of starvation arising out of temporary difficulties, killed her child, cooked it, ate of it, and offered the dish to her husband. Lastly, we have the so-called instinctive madness, of which the case of William Brown, given at length in Ray's 'Medical Jurisprudence of Insanity,' affords a good example.

* Quoted from Marc by Maudsley ('Physiology and Pathology of the Mind,' p. 309).

V. FEIGNED UNSOUNDNESS OF MIND.

Men feign insanity from the same motives which lead to the simulation of other diseases, and it is specially true of this class, that it is only by actual experience of the real disease that, in difficult cases, the counterfeit can be detected.

Idiocy.—This is rarely assumed, and, when feigned, is easy of detection. The idiot has almost always the defective formation of head, face, and person pointed out at p. 179; and it must always be practicable to learn so much of an impostor's history as that he was not always in the condition which he has assumed.

Imbecility.—In this case, too, the history, where it can be obtained, will assist in unmasking the imposition. The peculiar cast of countenance of the imbecile is not easy to imitate. The stupid, vacant, and wandering look, the unsettled and uneasy manner, the disconnected and evanescent ideas, the variable temper and spirits, the sudden and transient gusts of passion, and the foolish and childish acts, are, collectively, very difficult to assume. In the less strongly-marked forms of real imbecility, folly and acuteness are displayed indifferently on all subjects; but the impostor is shrewd on those which involve his interest or the success of his scheme, and displays his stupidity only in matters of indifference.

These cases, however, it must be admitted, present unusual difficulty of diagnosis, and give rise to great differences of opinion. We have had under our notice several cases of imbeciles certified as insane by the medical officers of prisons, and returned from the asylums as impostors; and other cases in which, after long and careful observation under most favourable circumstances, two equally competent observers have not been able to agree in their opinion. Unsettled habits, wandering and disconnected thoughts, sudden bursts of passion, unprovoked acts of violence, unsuccessful attempts at suicide, transient and half-formed delusions, short fits of industry, handiwork displaying much skill and ingenuity, make up a combination which it would be in the power of a good actor to assume. But imbeciles of this order possess sufficient shrewdness and self-control to conceal and moderate their eccentricities when they have an object to accomplish. So that it is quite possible for a real imbecile in prison to seem an impostor in an asylum. Nor must it be forgotten that the previous lives of these persons have been one continuous history of deception, and of shifty devices for living without work. (G.)

Dementia.—This is rarely imitated, that torpor of all the faculties which belongs to the true disease being hard to assume

and sustain; and we may be assisted in our diagnosis by discovering marks of the form of paralysis which attends one form of chronic dementia. Our chief difficulty in diagnosis may arise out of the rare obstinacy with which a prisoner—a female especially—will maintain a weak expression of countenance, repeat a few silly phrases, pass the excreta as if involuntarily, and resist every test that it is possible to apply. Such a malingerer may never have deceived the medical observer for a moment; but he may be compelled to wait patiently for a confession of the fraud.

Mania.—As it is more easy to assume the violence of mania than the more subdued characters of the foregoing forms of unsoundness, mania is more frequently feigned. The distinction between the fictitious and the true disease, though occasionally a work of time and patient observation, is not difficult; but in this, as in other feigned diseases, the impostor often obstinately resists the efforts of the medical man to obtain a confession of his fraud.

The peculiar intense expression of countenance, the marked alteration of feature, and the wildness of eye of real mania, are very hard to assume and maintain. The violent excitement, the loud shouts, the strong struggles and convulsive movements of the paroxysms also scarcely admit of imitation, and cannot be supported for any length of time. The real maniac will continue without sleep for days, and even weeks, or, if he sleep at all, his rest will be disturbed and agitated; but the impostor can scarcely keep awake beyond one or two days, and a dose of opium, which would produce no effect whatever on the madman, would infallibly send the impostor to sleep. The same remark applies to other remedies, such as emetics and purgatives. The madman will also go without food for days together with impunity, and little loss of strength; and is so insensible to external impressions that he will bear the most intense heat or cold, and gaze, without being dazzled, on the strong light of the sun. Other symptoms of less importance have been insisted on, such as the torpid state of the bowels, the moderate or low temperature of the trunk and limbs, a peculiar odour of the skin, and a frequent pulse.*

To this account of the physical signs of mania, it may be added that the impostor will overact his part during such times as he is watched; that instead of becoming more quiet and reserved on the approach of the physician, his violence increases; that he assumes a want of intelligence instead of that perversion of

* In the first edition of this work facts were adduced to show that the value of the pulse as a diagnostic mark had been exaggerated. All, perhaps, that can be safely affirmed is that an infrequent pulse, which often exists in healthy persons, would scarcely be compatible with mania.

reason which is so characteristic of the real affection; that he obtrudes instead of concealing his thoughts; that he pretends a defect of memory and apprehension which does not belong to real insanity, gives false answers to questions, and affects not to recognise persons whom he knows; that he does not recur constantly to the leading idea; that he betrays hesitation in the midst of his assumed violence; that he has not the steady gaze of the madman; that his fits occur suddenly and at irregular and convenient intervals, instead of having the periodicity of intermittent attacks of mania. It may be added, that instead of having a period of incubation so general in true mania, the first attack of his disorder is sudden. That perversion of the moral feelings which causes the madman to dislike every person to whom he was previously attached, being a symptom little known to the vulgar, is also not assumed by the impostor. Besides the diagnostic marks to be gleaned from the foregoing description, and the precautions already mentioned under the head of feigned diseases, some special tests have been recommended, such as repeating to the suspected person a series of ideas recently uttered, when the real maniac will introduce new ideas, but the impostor will repeat the same words. The use of the whirling chair has also been recommended, as producing giddiness and nausea in the impostor.

Partial Intellectual Mania.—Monomania, Melancholia.—These partial forms are less frequently feigned than general mania, or raving incoherence, and rarely with success. Many of the characters of mania already described, are present in cases of intellectual mania springing out of some excited emotion, such as pride or vanity. There is the same irritability of temper, the same violent prejudices, the same unfounded aversions and equally unfounded attachments, the same sleeplessness, the same insensibility to impressions, and to the operation of medicines. The pretended monomaniac makes a more open display of his assumed delusion than the real monomaniac, who rarely solicits attention. The true monomaniac is generally reserved, taciturn, and indifferent, but is easily excited and angered by opposition and argument. When hard pressed, men generally take refuge in violence, and women in tears.

The forms of intellectual insanity most commonly assumed, and most difficult to distinguish, are those which consist in the assumption of a single delusion, or of profound melancholy; and it is obviously difficult to lay down any diagnostic marks by which the real disease can be distinguished from the false.

The difficulty of diagnosis is seriously enhanced when, as some-

times happens, the malingerer is a good actor, and makes a faithful copy of the words and acts of a madman with whom he has been brought in contact in or out of an asylum.

Moral Mania, General and Partial.—General moral insanity, consisting of a strange combination of foolish, obscene, and cruel acts, may have to be distinguished from mere wickedness: but it is not apt to be assumed. To distinguish moral insanity from vice may be difficult; but, as a general rule, there is a strangeness and variety in the acts of the madman which do not belong to those of the sane criminal. As the character of the act or acts committed is the chief ground for believing in the existence of partial mania, there is no certain means of distinguishing the real from the feigned disease. It is, however, so unlikely that a sane man would be guilty of an act for which no motive can be discovered, with the certainty of being severely punished if found sane, and imprisoned for life if pronounced mad, that we may fairly assume such an act, if accompanied by all or many of the characters already pointed out, to have been the result of real moral insanity. The personal and family history of the accused would also afford some presumptions in favour of or against the theory of insanity.

Concealed Insanity.—The power of concealing his delusions, under the influence of some strong motive, has already been shown to belong to the madman; and long-continued observation, repeated interrogations, and careful inquiry into the patient's previous history may be necessary to bring the delusions to light.

VI. RULES FOR THE EXAMINATION OF PERSONS SUPPOSED TO BE OF UNSOUND MIND.

The main points to be attended to in the several examinations which the medical man may be required to institute, are the following:—

1. Observe narrowly the general appearance, conformation, and shape of the head; the complexion and expression of the countenance; the gait and movements, and the speech.

2. Ascertain the state of the health, of the appetite, and digestion, of the bowels, of the tongue, skin and pulse. Note especially the presence or absence of febrile symptoms, as important in distinguishing delirium from madness. Ascertain whether there is madness or excitement, restlessness or stillness, and whether the sleep is sound and continuous, or disturbed and broken. In females, inquire into the state of the menstrual functions.

3. The *family history* should be traced out, in order to ascertain

whether there is any hereditary predisposition to insanity, and whether any members of the family have been subject to fits, or have betrayed marked eccentricity of behaviour.

4. The *personal history* should be ascertained with equal care. If the mind appear unsound, ascertain whether the unsoundness dates from birth, from infancy, or from what time. If the unsoundness have supervened later in life, whether it followed severe bodily illness, accident, mental shock, long-continued anxiety of mind, repeated epileptic fits, or indulgence in habits of intemperance.

5. Inquire whether the present state of mind differs materially from that which existed when it was reputed to be sound; and whether the feelings, affections, and domestic habits have undergone any marked change.

6. Ascertain whether the existing unsoundness is a first attack, and if so, whether it began with depression or excitement; if not, did the first seizure follow a period of melancholy, passing into mania, and then into slow convalescence? If any signs of general paralysis are present in the speech or gait, has the patient squandered his money, grown restless, and wandered about, exposed his person, committed petty thefts, or had illusions of wealth and grandeur?

7. When our object is to ascertain the mental capacity, it must be tested by conversation directed to such matters as age, the birth-place, profession, or occupation of parents, number of brothers, sisters, and near relations, common events remote and recent, the year, the name of the month, and the day of the week, the name and family of the sovereign, and of persons best known and most talked of. The power of performing simple operations of arithmetic, and the knowledge of the value of money should be tested, and the memory by repeating simple forms of words in general use, such as the Lord's Prayer and Creed. In testing the power of attention, merely negative or affirmative answers to leading questions should be distinguished from such replies as indicate judgment and reflection. If the inquiry relate not to the capacity of the mind, but to its soundness in other respects, delusions should be sought for by conversations directed to those topics that are most likely to interest and excite the mind. The state of the moral feelings will be tested by conversation directed to relatives and friends. In cases of supposed moral insanity, diligent inquiry should be made into the motives which might have led to the commission of the act of which the party is accused.

8. The medical man should insist on full opportunity being

given him of forming his opinion. He should rarely content himself with a single visit; and in cases of great difficulty, should require that the party be placed for some time under his observation.

9. When undergoing examination in a court of law, the medical witness is recommended to avoid all definitions of insanity, on the plea that mental, like bodily diseases, do not admit of definition, but are subjects for description.

10. In signing certificates of lunacy, the medical man should bear in mind that he is required to see the patient by himself, to sign the certificate at the time of the visit, and to assign the reasons which have influenced him in attaching his signature to it.

To the foregoing directions a few practical suggestions and hints may be added with advantage relating to the two important and responsible duties of the medical man—imposing restraint and signing certificates.

Restraint.—The medical man, in the exercise of his profession, may be called to a patient suffering from fever, delirium tremens, or mania, and may find him in a state of excitement dangerous to himself and to those about him. It seems as natural to him to order the patient to be restrained as to prescribe medicine for him. If he were not to order him to be placed under restraint, and the patient were to destroy himself or others, he would expose himself to the indignant censure of the whole community. But if, in the exercise of his discretion, he makes arrangements for restraining the patient, and the patient, on recovery, real or apparent, pleases to sue him for damages, he may inflict upon him the annoyance, loss of time, and expense of a trial by jury. This risk, it appears, cannot be avoided; but it may be reduced by the medical man observing the precaution of obtaining a written authority from the nearest relative in attendance on the patient—from husband or wife, father or mother, brother or sister, as the case may be.

Certificates.—In the case of paupers one medical certificate only is required, with an order signed by a justice of the peace, or, in his absence, by the relieving officer or overseer and the officiating clergyman of the parish in which the lunatic is at the time. In all other cases the certificates of two medical practitioners and the formal demand of a relation or friend. These certificates, to be valid, must be signed by legally qualified practitioners having no interest, direct or indirect, in the patient, or in the establishment to which he is to be sent; they must bear the exact address of the patient, and the date of the examination and signature; the visit must be a separate visit (each

medical man examining the patient separately); and the certificate must set forth distinctly the grounds of the opinion, under the distinct heads of facts observed by himself, and facts communicated by others (such others to be specified); and be signed with name, address, and date. It remains valid only for seven days. If defective it may be amended.

A proper printed form in accordance with the statutes regulating the custody and treatment of the insane, and containing plain marginal directions, may be obtained of the law stationers. It comprises a "Notice of Admission," to be signed by the superintendent or proprietor of the asylum, to be forwarded to the Commissioners of Lunacy within one clear day from the patient's reception; an "order for the reception of a private patient" addressed to the proprietor or superintendent of the establishment, and signed by a person who specifies his "degree of relationship (if any)" with a "statement" containing a detailed account of the patient and his history; and, lastly, two identical forms of "Medical Certificate," of which we append a copy (p. 232).

In the case of insane persons wandering abroad, without proper care, provision is made for their protection by 16 & 17 Vict. secs. 67, 68, and 70: which inflict a fine of 10*l.* on medical officers of parishes, as well as on overseers or relieving officers, who, having knowledge, in any way obtained, that a lunatic is "wandering at large" or "not under proper care and control" or "cruelly treated or neglected" does not take measures to bring the case before a magistrate. Additional protection is afforded to the insane person, and to the public by sec. 68 of this Act, which makes it "lawful for any justice, upon its being made to appear to him by the information upon oath of any person whomsoever that any person wandering at large within the limits of his jurisdiction is deemed to be a lunatic, by an order under the hand and seal of such justice, to require any constable of the parish or place, or relieving officer or overseer of the parish where such person may be found, to apprehend him and bring him before such justice," &c.*

* The reader will find much valuable information on the legal relations of insanity, and on the duties of medical men in charge of asylums, as well as on the whole subject of unsoundness of mind, in Dr. Sankey's 'Lectures on Mental Disease,' 1866, and in the 'Handbook of Law and Lunacy,' by Dr. Sabben and J. H. Balfour Browne, 1872. Those who are directly interested in the care and custody of the insane should consult 16 and 17 Vict. cap. 96 and 97, also 8 and 9 Vict. cap. 100.

MEDICAL CERTIFICATE.—SCHED. (A.) No. 2, Sects. 4, 5, 8, 10, 11, 12, 13.

I, the undersigned,
being a (a)

and being in actual practice as a (b)
hereby certify, that I, on the Day of
at (c)
in the County of separately from any other Medical Practitioner
personally examined
of (d) and that
the said
is a (e) and a proper person to be taken charge of and detained under Care and Treatment, and that I have formed this opinion upon the following grounds; viz.:—

1. Facts indicating Insanity observed by myself (f)
2. Other facts (if any) indicating Insanity communicated to me by others (g)

Signed, *Name*, _____

Place of Abode, _____

Dated this Day of One Thousand Eight Hundred and Seventy

(a) *Here set forth the qualification entitling the person certifying to practise as a physician, surgeon, or apothecary, ex. gra.* —Fellow of the Royal College of Physicians in London, Licentiate of the Apothecaries' Company, *or as the case may be.*

(b) Physician, surgeon, *or* apothecary, *as the case may be.*

(c) *Here insert the street and number of the house (if any), or other like particulars.*

(d) *Insert residence and profession, or occupation (if any), of the patient.*

(e) Lunatic, *or* an idiot, *or* a person of unsound mind.

(f) *Here state the facts.*

(g) *Here state the information, and from whom.*

PART II.

CHAPTER I.

RSONS FOUND DEAD—REAL AND APPARENT DEATH—SUDDEN DEATH—SURVIVORSHIP.

ER the general heading of *Persons found Dead* the precau- to be observed in conducting inquiries concerning those e mode of death is unknown, will be discussed. As the first tion that naturally arises is as to the reality of death, the ct of *Real and Apparent Death* follows in order; then *den Death*, in which some of the more common modes of lution are briefly considered; and, lastly, *Survivorship*.

PERSONS FOUND DEAD.

treating of Medical Evidence, instructions were given as to best mode of stating facts and opinions in a court of law, so give them their full force, and to render them admissible as ence. In this place, directions will be given for observing and cting that important class of facts which refers to persons d dead; in other words, for discharging, in reference to such ons, the functions of a common and of a skilled witness. If for to a dying man, or to one already dead, the medical must needs observe many things connected with the body f, such as the position in which it is placed, and the objects h surround it, that might as well be observed and stated in ence by any other person; but a post-mortem inspection if ired, must be entrusted to himself or to some other skilled ber of the profession. Hence the present inquiry branches nto two divisions. 1. *The relations of the body to surround- objects.* 2. *Directions for the performance of* post-mortem *ections for legal purposes.*

I. RELATION OF THE BODY TO SURROUNDING OBJECTS.

The medical man is summoned to most cases of severe illness or sudden death, and thus becomes one of the first, and probably one of the best educated and most intelligent witnesses of those simple facts which, in criminal cases, constitute the presumptive or circumstantial evidence. He should therefore, especially in suspicious cases, be attentive to all that is passing around him, that no object, however trifling, calculated to throw light on the cause of death, may be overlooked. The following are some of the principal points which should engage his attention: —

The place in which the body is found.—This is not always that in which death took place; for, in suicidal as well as homicidal cases, persons severely wounded may be able to move some distance from the spot on which their injuries were received, and the murderer may try to conceal his crime by carrying the body to a place remote from the scene of violence.

The position and attitude of the body.—This may not correspond with the cause of death, as when the body of a man killed by a blow on the head was found standing upright, supported by a wooden fence; and murderers often so dispose the bodies of their victims as to make it appear that they had committed suicide. Thus, persons have been poisoned, and afterwards suspended by the neck, or thrown into the water; and the body of Sir Edmundbury Godfrey, who was proved to have been violently strangled, was found lying in a ditch, pierced with his own sword, and with his clothes so arranged as to create the belief that he died by his own hand. From observations made on the field of battle, it is inferred that men killed in a hand-to-hand struggle often wear an expression of rage, contrasting strongly with the calm expression of those killed by gunshot. Some soldiers, too, are found in the very attitude in which they died. If we find an expression of angry resistance on the face, hands, and body, we may infer that death was the issue of a struggle.

The spot on which the body is found.—In cases of fatal injury to the head, it is usual to allege that the death was caused by a fall on some hard resisting body; an allegation only to be rebutted by an examination of the spot. Thus, the death of a man found lying in a field with a severe bruise on the head, having been attributed to a fall on a stone or fragment of wood, the field was carefully searched, and no such object could be found near the spot on which the body lay. In another case, a small wound of the head, which had penetrated to the brain, and had been received *during* a murderous struggle, was attributed to a fall on a sharp

object, such as a nail fixed in the floor; but the floor having been examined, and no such object found, it followed that the wound had been inflicted by a small-pointed instrument. The murderer, after his acquittal, which was due to defective medical evidence, confessed that he had struck his victim with the point of a pair of snuffers.

The soil or surface on which the body lies.—Struggles often leave on the spot traces which may be compared with the clothes of the suspected murderer or of his victim, and foot-prints in the snow, or on the soil, have often furnished important evidence. Sir Walter Scott gives an account of a murder discovered by the print of the murderer's foot on the clay floor of a cottage in the death-struggle. The measure of the foot, the tread, and the mode in which the sole of one of the shoes had been patched, corresponded most closely with the foot-mark; and this was the first link in the chain of evidence which led to the conviction of the murderer. In cases of murder, followed by the suicide of the murderer, important light has been thrown on the transaction by finding stains of blood on the floor, and on the soles of the feet of the perpetrator of the double crime.

Position of surrounding objects.—In suicidal cases the instrument of death is generally found near the body; in homicidal cases it is often removed and concealed. In death by the more active poisons, the vessel which contained the poison is often found on, or close to, the person. The correspondence of wounds or bruises found on a dead body with the objects immediately surrounding it, sometimes throws great light on the cause of death. Thus, in the case of the Prince de Condé, who was found suspended by the neck in his bed-room, the correspondence of certain abrasions on the legs with a heavy chair placed close to them, and of others on the shoulder with a projecting part of the window to which he was suspended, harmonized with the struggles of a man suspended during life, and justified the opinion of those who attributed the death to suicide.

The Clothes.—Having noted the place and spot on which the body lies, its position, and the objects by which it is surrounded, a more close inspection should be made of the body itself. The clothes may be soiled with mud, or corroded by an acid, or stained by blood, or some animal secretion; or they may be torn or cut. The character and position of the stains, and the direction of the rents or cuts, should be carefully noted; and cuts which traverse more garments than one should be compared with each other, and with wounds found on the body; for a murderer may try to conceal his crime by cutting the clothes after he has wounded the

body, and that the wounds and incisions may not coincide. It is scarcely necessary to state that criminals are being constantly identified through the close correspondence of things found in their possession with those used in the perpetration of the crimes themselves. The bearing and conduct of the parties in attendance on sick, dying, or dead persons should not be overlooked, especially in cases of suspected poisoning.

To what has now been said respecting persons found dead, it may be well to add that neither examples nor rules can do more than suggest the sort of inquiries that may be needed. There is always great scope for individual judgment, foresight, and decision. The service which an intelligent medical witness may have it in his power to render to the cause of justice cannot be better illustrated than by a case, for which the author is indebted to the late Dr. James Reid. It is given, as nearly as possible, in his own words:—"I was sent for one day to a man and his wife, whom I found lying in the same room with their throats cut. The woman was on the floor, with her right arm extended under the bed, and a razor close to her right hand. Her throat was deeply cut from ear to ear, and she lay in a complete pool of blood. The husband, who was in bed, had a wound in the throat, which had merely divided the trachea without wounding any important blood-vessel, and without causing any great loss of blood. When questioned, he gave the following account:—In the middle of the night he was roused from sleep by receiving a wound in the throat from the hand of his wife. The shock, the wound, and the loss of blood together, had prevented him from making any resistance or giving any alarm. My suspicions were roused, partly by the man's manner, and partly by observing the water in a basin standing in the room slightly tinged with blood. In endeavouring to find some confirmation of my suspicions, a thought struck me. I turned up the bed-clothes, and found the soles of the feet covered with dried blood. This fact, which I stated at the coroner's inquest, was deemed conclusive, but the man died almost at the moment that the verdict was passed."

II. EXAMINATION OF THE BODY.—POST-MORTEM INSPECTION.

The medical man, having discharged the duty of a common witness by noting all those points of presumptive or circumstantial evidence which may throw light on the mode and cause of death, proceeds to the examination of the body itself. When it is that of some person unknown, those characteristics which may lead to *its identification* should be noted down, in accordance with instruc-

tions given at p. 7. Those appearances which serve to denote the time of death (see p. 242) should next be observed, and then any external injuries the body may have received.

If any wounds, bruises, or excoriations exist, their nature must be specified, and their extent determined by exact measurement. The neck, back, and limbs should be examined in search of dislocations or fractures, the chest compressed, to ascertain whether blood, or any fluid, mixed with air or gas, escapes from the mouth or nostrils; the cavity of the mouth inspected, in search of foreign bodies, or stains of corrosive poisons; and the anus for poisons introduced into the body by that opening. In new-born children the orbits, fontanelles, and nuchæ should be searched for minute wounds inflicted by pointed instruments; and in women, the point of junction of the breasts (especially on the left side) with the skin of the chest. The female organs of generation should also be examined in search of poisons, corrosive acids, or wounds.

Post-Mortem Inspection.—The great rule to be observed in conducting post-mortem inspections for medico-legal purposes is to examine every cavity and important organ. Even when the cause of death is quite obvious, it is well to observe this caution; for if any part of the body have been left unexamined, the objection may be made that the cause of death might have been found there, or some disease which would have given a mortal character to an injury not otherwise fatal. The order in which the cavities are examined must depend mainly on the supposed cause of death. As a general rule, the seat of injury should be inspected first, before the contents of the blood-vessels have been disturbed by the examination of other parts. It must be quite unnecessary to insist on the duty of conducting every step of the examination with care and circumspection. Specific directions for post-mortem examinations in cases of rape, delivery, poisoning, infanticide, &c., are given under those heads.

REAL AND APPARENT DEATH.

This subject has never attracted much attention in England, and no medical author of repute has treated it at any length. In earlier periods of our history persons ran some risk of being buried alive, but this risk has now disappeared, and is not likely to recur unless in the improbable event of some fatal epidemic rendering speedy interment expedient. But the question of real or apparent death may assume practical importance long before the usual period of interment arrives; for in cases of suspended animation, the adoption, neglect, or speedy abandonment of

measures for restoring life, must depend on the previous answer to the question—Is life really extinct?

On the Continent, and especially in France (in consequence of the practice of early interment, and the Roman Catholic rite of extreme unction, which raises a serious impediment to the use of means for restoring animation), this subject is treated with greater respect, has employed the pens of such distinguished medical writers as Winslow, Bruhier, and Louis, and has received some attention at the hands of Malion, Foderé, and Orfila.

There are three forms of suspended animation which may be mistaken for real death—*syncope*, *asphyxia*, and *trance*.

1. *Syncope.*—In the majority of instances, the apparent death, about which so much has been said and written, was merely a prolonged faint. This is proved by the success which attended the accidental employment of the very means most efficacious in restoring those who have fainted, namely, cold water and fresh air.

The efficacy of cold water is attested by Hippocrates in the case of a woman apparently dead from fever; and by John Howard, who bears his personal testimony to the restoration of supposed victims of gaol fever, brought out for burial, on being washed with cold water!

The efficacy of pure cold air rests on the authority of Diemerbröck and Zacchias in cases of plague, and well authenticated instances of recovery after small-pox are on record; one of which occurred in the person of an infant daughter of Henry Laurens, the first President of the American Congress. She had small-pox, and was laid out as dead; but the window of the apartment, that had been carefully closed during the illness, being thrown open, the fresh air revived her. Such cases were not of rare occurrence before the time of Sydenham, who abolished the stifling system of treating eruptive diseases, especially small-pox.

From what has just been stated it may be inferred that there is nothing improbable in the cases in which recovery from apparent death is alleged to have occurred at the touch of the scalpel, or in ancient times under the flame of the funeral pyre.

2. *Asphyxia.*—This is a form of suspended animation liable to be mistaken for real death, and only to be distinguished from it by the result of the means employed for the recovery.

3. *Trance.*—Cases of suspended animation, not answering exactly to the description of syncope or asphyxia, occasionally occur in females. The motionless and insensible state of the frame, the cold surface, and the apparent suspension of respira-

tion and circulation, combine to produce a semblance of death, and to create temporary difficulty even for the medical man.

The subject of real and apparent death would be incomplete if some notice were not taken of those cases in which a state of apparent death has been brought about by an effort of the will. The occasional occurrence of such cases has been placed beyond the reach of doubt; and a minutely described and well authenticated instance of this kind, that of the Honourable Colonel Townshend, is related by Cheyne in his 'English Malady.'

"He told us he had sent for us to give him some account of an odd sensation he had for some time observed and felt in himself; which was, that composing himself, he could die or expire when he pleased, and yet, by an effort, or somehow, he could come to life again, which, it seems, he had sometimes tried before he had sent for us. We all three felt his pulse first: it was distinct, though small and thready, and his heart had its usual beating. He composed himself on his back, and lay in a still posture some time; while I held his right hand, Dr. Baynard laid his hand on his heart, and Mr. Skrine held a clean looking-glass to his mouth. I found his pulse sink gradually, till at last I could not feel any by the most exact and nice touch. Dr. Baynard could not feel the least motion in his heart, nor Mr. Skrine discern the least soil of breath on the bright mirror he held to his mouth. Then each of us by turns examined his arm, heart, and breath, but could not by the nicest scrutiny discover the least symptom of life in him. This continued about half an hour. As we were going away (thinking him dead), we observed some motion about the body, and upon examination found his pulse and the motion of his heart gradually returning; he began to breathe gently, and speak softly." This experiment was made in the morning, and he died in the evening. On opening the body nothing was discovered but disease of the kidney, for which he had long been under medical treatment, all the other viscera being perfectly sound.

This case of Colonel Townshend is not only curious but instructive, for it shows that there is at least one state of system so nearly resembling death as even to deceive medical men, distinguishable from real death only by the continuance of animal heat, the absence of rigidity, and the success of the means of restoration; and this fact admits of practical application. It teaches us that we should not hastily abandon the attempt to resuscitate persons who have appeared to perish by syncope or asphyxia, by hæmorrhage, shock, sun-stroke, drowning, and the several forms of suffocation.

Signs of Death.—Of the signs of death insisted upon by authors some are trivial and inconclusive, others of considerable importance, both as signs and as means of forming a judgment of the time that life has been extinct. To the first class belong the *Cessation of the Circulation and Respiration; the Absence of Sense and Motion; the Facies Hippocratica, the State of the Eye; the State of the Skin*, and *the Extinction of Muscular Irritability* To the latter class belong the *Extinction of Animal Heat; Cadaveric Rigidity;* and *Putrefaction.*

Cessation of the Circulation.—If no pulse can be felt at the wrist, and the beat of the heart can neither be felt nor heard with the stethoscope, it may be assumed that the circulation of the blood has ceased, though it is possible that very feeble movements of the heart might escape observation. The absolute cessation of the heart's action may be taken as a sure sign of death. The great difficulty, however, is to ascertain this beyond the reach of doubt. It is not enough merely to feel the pulse at the wrist, for, as in Colonel Townshend's case, even experienced medical men might be unable to detect pulsations, and conclude that the heart had ceased to beat. It requires the application of the stethoscope by an experienced person for several seconds, repeated at short intervals, before it can be said with any degree of certainty that the heart has quite ceased to beat. But if the heart does not beat for five minutes, we may conclude that death is certain. The cessation of the heart's action for a much less period than this would cause death; but its cessation for five minutes would, in our opinion, be conclusive. The apparent death of the Indian fakirs is much more remarkable than the case of Colonel Townshend; but there is no reason to suppose that in them the heart ceases to beat, though the vital processes may be reduced to the lowest ebb.

On account of the difficulty attending the use of the stethoscope by uninstructed persons, Magnus has proposed an ingenious method of ascertaining whether the circulation has or has not ceased. He recommends that a ligature be applied to a finger, when, if there is life, a ring of arterial anæmia shows itself round the seat of the ligature, and a gradually increasing redness and lividity in the part beyond. This is a simple plan that may be practised by the inexperienced.

Cessation of the Respiration.—The circulation and the respiration are so connected, that what is true of the one is likely to be true of the other. The tests of respiration—the looking-glass, and feather held to the mouth, and the cup of water placed on the chest or abdomen—are at least as delicate as those by which we

seek to determine the continuance of the heart's action. It is scarcely possible that respiration, however feeble, should take place, and yet escape detection by such means; and yet in the case of Colonel Townshend, the glass remained for a long period unsoiled, and no sign of respiration could be detected. The suspension of the respiration, therefore, is not a sure sign of death.

But the joint cessation of the respiration and circulation, when properly ascertained, would prove the fact of death.

These signs are supported by the following, which, though not of themselves conclusive, support each other.

Absence of Sense and Motion.—This is common to suspended animation and real death; and therefore uncertain. The combination is not rare in hysteric females, and in the mesmeric slumber; but in these cases the functions of circulation and respiration go on uninterruptedly, often combined with a vibrating movement of the eyelid, which forms an exception to the general rule of immobility.

The Facies Hippocratica.—This peculiar expression of countenance, combining the sunken eye, sharp nose, pointed chin, hollow temple, prominent cheek-bone, projecting ear, and wrinkled brow; the dry livid skin, and the white powdered hair of the nostrils and eyebrows; is a trivial and unsafe sign of death, open to the serious objections:—1. That it is nearly always absent in cases of sudden death, and in the victims of acute disease. 2. That it is present in the dying as well as the dead, and even in cases that have recovered. 3. That it may be brought about by a strong impression of danger, the apprehension of a dreadful punishment, or the anticipation of certain death. And 4. That where it exists, it does not long survive the extinction of life.

State of the Eye.—A tenacious glairy mucus on the conjunctiva, causing a loss of transparency in the eye, and a collapsed and wrinkled cornea, are among the best and earliest of the trivial signs of death. But they are not conclusive; for, on the one hand, the conjunctiva may be invested by a mucous film and the eye may lose its brilliancy in the living, and, on the other hand, in death from *apoplexy*, *carbonic acid*, and *prussic acid*, the eyes may continue brilliant and prominent for a long time. Putrefaction, too, or a ferment introduced into the stomach, by distending the body with gas, sends blood to the head, and makes the eyes brilliant and prominent. (Nysten.)

State of the Skin.—*Pallor*, owing to absence of circulation; *livid discolorations*, due to the subsidence of the blood; and *loss of elasticity*, have been mentioned among the signs of death.

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Pallor may exist during life, and be absent in several forms of death, especially in death from suffocation, and livid discolorations are common in aged and feeble persons in depending parts of the body. But loss of elasticity is a valuable sign, and one very early developed.

Extinction of Muscular Irritability.—This test was first proposed by Nysten; and is a certain sign of death. If a muscle be laid bare and tested by puncture or by the galvanic fluid, and there is no contraction, the body is dead; but its contraction would be a proof either of life or recent death. Rosenthal has recently advocated it both as a sign of death, and as a means of determining approximatively the date of the death. He states that the electric excitability may continue three hours after death. If the excitability exists, it indicates either life or recent death; and if found to exist more than three hours after life is supposed to be extinct, it indicates its persistence. By this method he diagnosed a case of apparent death forty-four hours after the person was supposed to have died, and so prevented premature interment.

Among the trivial signs of death, the flexure of the thumb across the palm of the hand may be mentioned. It assumes this position before cadaveric rigidity comes on, but it is similarly contracted during life in certain spasmodic affections.

The foregoing signs do not supply the means of determining how long life has ceased. But the extinction of animal heat, rigidity, and putrefaction, being both certain signs of death, and means of determining, with more or less precision, the time at which death took place, must be examined more closely.

SIGNS OF DEATH WHICH ARE ALSO MEANS OF DETERMINING HOW LONG LIFE HAS BEEN EXTINCT.

Extinction of Animal Heat.—The temperature of the body is closely dependent on the circulation of the blood; so that when this ceases, in a part, or in the entire frame, that part, or the whole body, soon becomes cold. Hence the extremities grow cold before death; and even the internal parts cool down, as is shown by the coldness of the breath; and at length, when life is extinct, every part becomes cold. But as, on the one hand, great coldness is often present during life, and in cases of suspended animation, and, on the other, after sudden and violent death the body often parts with its heat very slowly, the value of this sign is impaired. An anomalous restoration of heat, without any other sign of life, has also been observed to take place after death by cholera; and Mr. Savory has shown that in a

rabbit and dog killed by strychnia, the temperature rose one or two degrees after life was extinct.

Nor is the extinction of animal heat a sure means of determining the time of death; for the rate of cooling of the body varies with the age, the cause of death, the treatment of the body itself, and the state of the atmosphere; so that the period of cooling may vary from two or three hours to fifteen or twenty, and may even extend to upwards of four days.

The body cools slowly when clothed and exposed to a warm, still atmosphere, quickly when exposed naked to a draft of cold air. It parts with its heat more speedily in water than in air. Age, emaciation, and death by hæmorrhage or chronic disease, favour the cooling; youth and vigour, corpulence, and acute disease or speedy death retard it. In persons dying of the same disease, the extinction of animal heat is, *cæteris paribus*, as the rapidity with which it proves fatal. In chronic diseases, the body parts with much of its heat during life.

Some important medico-legal cases which have lately occurred (Cases of Hopley, 1860, Doidge, Gardner the Sweep, and Jesse M'Pherson, 1862), have shown the necessity of examining this subject more closely, with a view, if possible, of determining the rate of cooling of the dead body, and the time of death. Accordingly Drs. Taylor and Wilks have recorded a series of observations on bodies transferred from the wards of Guy's Hospital to the dead-house. Out of 100 observations so made, 70 are available for a philosophical inquiry, and the facts, when submitted to careful examination and analysis, are found to yield some instructive results. The bodies when removed from the wards to the dead-house, were placed in an open shell, and covered only with a shirt, shift, or sheet; and from the time of deposit in the dead-house the temperature of the skin of the abdomen was ascertained at various successive intervals, by the thermometer. 70 complete observations, recording the temperature of the wards and dead-house, as well as of the body, and extending over the period from February to June, 1863, gave for the wards a range from 50° to 68° Fahr., and for the dead-house from 38° to 59°. Though several of the observations extended to from 16 to 20 hours, the body, in no case, fell to the temperature of the air, the nearest approach to it being in the case of a girl æt. 19, who died of phthisis, and in whom 16 hours after death the temperature of the body had fallen to 52°, that of the dead-house being 48°. It is clear, then, that the cooling of the body, even when covered only by a single layer of cotton or linen, is a very *slow process*, and that in the case of a body

clothed, or in bed, and in a room of moderate temperature, it would be unreasonable to expect the cooling of the body till the lapse of upwards of 24 hours at the very least. It ought also to be understood that the temperature of the body, when first ascertained two hours after death, in 18 instances presented a maximum of 88°, a minimum of 76°, and a mean of 83°; also that on an average the rate of cooling is about one degree per hour. If then, in any case, we assume the temperature of the abdomen at death to have been 90°, and the temperature of the air 60°, it would not be reasonable to expect the temperature of the abdomen to have fallen to that of the air till the lapse of at least 30 hours. These statements are the result of an analysis which we have made of the facts contained in the tables.* But these facts and inferences must be applied to individual cases with great caution; for not only have we every variety of cause of death (both disease and accident), but an unusual exposure of the body; and a rate of cooling, which though on an average about a degree an hour, was in some cases as low as ½°, and in others as high as 2°, 3°, or even 4°.

By extracting from the tables the cases of death by accident, eight in number, assuming the rate of cooling from the period of death to the date of the first observation to have been equal to that subsequently ascertained, and disregarding the ascertained temperature of the dead-house, I have obtained the following figures as applicable to death by violence, followed by free exposure of the body to the air with a single light covering:—average temperature of abdomen at death, 83°; range of temperature of abdomen at death, 79°—89°; rate of cooling per hour, about 1°, or approximatively 13° in 11 hours. These are the most precise data we now possess applicable to cases of violent death; and we cannot approximate nearer to the truth than by assuming a temperature at death of 83°, and a rate of cooling per hour of more than one degree if the body is exposed, or less than one degree if it is clothed.

The use of the thermometer may be very properly insisted on in every case, as much more satisfactory than the sensations of the observer: and it is not to be doubted that very incorrect inferences may be drawn from the sensation of cold as imparted to the hand of an observer on touching the hands or feet, the nose or ears, of a corpse recently dead. A man must have little experience of living bodies who does not know what a sensation

* 'On the Cooling of the Human Body after Death.' By Dr. Alfred S. Taylor and Dr. Wilks: 'Guy's Hospital Reports,' Oct. 1853, p. 154.

of icy coldness may be imparted to the warm hand by contact with the hands or feet of another.

Cadaveric rigidity—Rigor mortis.—For some time after life is apparently extinct, the muscles continue to contract when stimulated. The extreme duration of this irritability, even in the muscles of voluntary motion, does not exceed two or three hours; and when it ceases, cadaveric rigidity sets in. The experiments of Vulpian and Brown-Séquard show that this irritability of the muscles lasts longer in a low temperature than in a higher one; and the last-named author proved by experiment that both the contractility of the muscles might be restored, and the rigidity of the corpse be destroyed for a time by injecting defibrinated arterial blood, or aerated venous blood, into the vessels;* also that the rigor mortis may be hastened by exhausting the irritability of the muscles by powerful and repeated galvanic shocks.

This phenomenon occurs in all classes of animals alike, and is the first certain evidence of death. It makes its appearance long before the body has cooled, and commences in those parts that lose their heat the latest. It may even set in before the heart has ceased to beat. On the other hand, it may be delayed twenty-four hours or more; and it may last for a few minutes or for several days, or even as long as two or three weeks. Its seat is in the muscles, and it is due to the coagulation of the muscle plasma, and the formation of myosin, or muscle fibrin. So long as the muscles remain entire, the limbs continue inflexible, unless great force be used; but when they are cut or torn, the rigidity ceases. It takes place in all positions of the trunk and limbs, without changing those positions. It shows itself successively in the muscles of the back, of the head and lower jaw, in those of the face, in those of the neck and chest, in the arms, in the legs: and it disappears nearly in the same order; the muscles of the lower extremity often remaining rigid when those of the trunk and upper extremity have resumed their state of relaxation. It is entirely independent of the nervous system, for it comes on after the nerves have ceased to be excited by the galvanic fluid. A division of the nerves, even the removal of the brain, does not prevent it; and in death from apoplexy or hemiplegia, the paralysed limb is affected in the same way, and to the same extent, as the sound one. It is strongly marked and persistent in muscular subjects, and, as a general rule, it lasts long when it sets in late. In death by lingering diseases,

* See Savory's fourth lecture on 'Life and Death' for several facts cited in this chapter.

such as low fever, consumption, and scurvy, and the diseases of old age, the rigidity sets in very speedily, and disappears again in the course of one or two hours. It also sets in very soon in animals over-driven or hunted to death, in soldiers killed late in a battle, and in persons exhausted by convulsions (Savory). It may even set in immediately after death, so that muscular contraction passes into the condition of muscular rigidity, without the occurrence of an intermediate stage of relaxation. This condition has been termed 'cadaveric spasm.' The spasm of strychnia poisoning is said to pass thus directly into cadaveric rigidity, though some recognise a short interval of relaxation. It is not an unusual occurrence in cases of violent and sudden death, especially where there has been great nervous excitement. It has been specially observed in some cases of death in battle, in which the very attitude and expression at the moment of death are retained, and weapons are found grasped in the hand. And as the soldier will be found grasping his rifle in the act of taking aim, so will the suicide or murdered person be found clutching the object he held the moment before. This fact is of great importance in a medico-legal point of view. Thus, a razor or pistol found firmly grasped in the hand of a dead man would afford a strong presumption of suicide. It could not be successfully imitated by a murderer. The cause of this sudden transition of spasm into cadaveric rigidity is not satisfactorily made out. On the other hand, in death by acute inflammation of the stomach or viscera, by irritant poisons, whether mineral, vegetable, or aerial (provided they exert no specific influence on the contractile powers of the muscles), the rigidity is for the most part slow in making its appearance, strongly developed, and lasts for a considerable time. After death from cholera rigidity is said to commence very early, and to last four or five days. It is slow in showing itself in death from apoplexy, hæmorrhage, wounds of the heart, decapitation, injury of the spinal marrow, and asphyxia. Its duration in poisoning by carbonic acid is very considerable, and in one case Nysten found that it continued seven days. On the other hand, in poisoning by sulphuretted hydrogen, rigidity does not occur; and Casper alleges that it either does not take place after narcotic poisoning, or lasts a very short time. It is slightly developed, and of short continuance, in the new-born infant. A low temperature, and recent indulgence in spirits, are mentioned by Casper as favourable to the persistence of cadaveric rigidity; and in those cases where it lasts longest he has found it to coexist with putrefactive changes. —('Handbook,' vol. i. p. 30.)

Cadaveric rigidity cannot be mistaken for the stiffness caused by intense cold, nor for any other condition of the dead body.

The muscular rigidity present during life in such diseases as catalepsy and tetanus, is readily distinguished from cadaveric rigidity by forcibly bending the limb: if due to a vital contraction, it resumes its position, which does not happen in the rigidity of death.

Rigidity, then, is a certain sign of death, and not to be confounded with any state of the living body, and as it supervenes after the extinction of muscular irritability, it is a sure indication of the hopelessness of attempts at resuscitation.

Cadaveric Lividity, or Hypostasis.—This, too, is an infallible sign of death, not requiring to be distinguished from any condition of the living body.

In the interval between the extinction of life and the commencement of putrefaction, the body falls more and more under the influence of physical laws. The skin loses its elasticity, and the flesh its firmness, and the blood, which was equally distributed through the body, now gravitates towards the most depending parts. Hence the paleness of some parts and the deep violet tint of others, the discoloration of the occiput and back, and of the lowest lying parts of the intestines, lungs, and brain. These discoloured patches begin to form, on the average, in from 8 to 12 hours after death. The seat of the lividity is determined by the posture of the body, so that if it be placed on the face, it will occupy the anterior part of the body and of the viscera. If again, after discolorations have formed on the back, the body be turned while still warm, and before the blood has coagulated, they will disappear. These discolorations are often very extensive, and when the body lies on a smooth surface, uniform in tint; but if the surface is uneven, the discolorations are interrupted and irregular. The pressure of the clothes produces the same effect; so that a careless observer might mistake the marks of clothes fastened round the neck for the effect of strangulation, or isolated patches for severe bruises.

The extent and amount of discoloration are proportioned to the quantity of the blood, so that its prevalence through the whole body indicates a general fulness of the vascular system, and *vice versâ*. Sudden death, unattended by loss of blood, is characterized by extensive lividity; but lividity is not absent even in cases of death from hæmorrhage.

This subsidence of the blood explains the diminished intensity of colour in parts which had been the seat of the less severe and more diffuse forms of inflammation. But the appearances pro-

duced by such acute inflammation as follows burns and scalds, blisters, and strong friction, and the action of the more violent irritant poisons on the internal parts, are permanent, and quite distinct in the dead body.

Cadaveric lividity must not be mistaken for ecchymosis or extravasation into the cutaneous tissues, the result of injury. They are easily distinguished from each other by making an incision into the discoloured spot. In hypostasis the cut surfaces will exhibit a few *puncta cruenta*, or bloody points, which are the open mouths of small blood-vessels, while in ecchymosis the blood will be found diffused into the cutaneous tissues.

As hypostasis consists simply in the gravitation of the blood, whether externally in the skin, or internally in the viscera, it is of importance that this vascularity of the internal parts should not be mistaken for the signs of inflammation. Mistakes of this kind have been made in reference to the brain, lungs, and intestinal canal.

In connexion with this subject of the subsidence of the blood, it will be necessary to notice the coagulation and consequent separation of the constituents of the blood which takes place after death. This subject was ably treated by Sir James Paget, in a paper published many years since.* He there shows that the blood contained in any cavity or vessel of the body at the time of death, coagulates as it would do if drawn into a basin, or other vessel, during life; that the part of the blood which occupies the highest position in the body, like the buffy coat of inflammation in blood drawn during life, is least coloured, and that which lies lowest the most; that such highest portion may be like a nearly colourless jelly, while the lowest has a deep blue or black colour; that this post-mortem separation is distinguishable from similar separations during life, inasmuch as the latter adhere in layers (as in the sac of an aneurism) to the containing cavity or vessel; and lastly, that, in most cases, the blood does not coagulate in the body till the lapse of from four to six, eight, or more hours, but yet coagulates within a few minutes of being let out of the vessels. Sir James further shows that these phenomena of post-mortem coagulation may have a practical application in determining the posture in which the body was left for some time after death; and he gives in illustration the case of a man suffering from excessive dyspnœa, who died sitting up with his head resting on his knees, and so remained for three or four hours after death. The relative position of the constituents of the

* On the Coagulation of the Blood after Death: 'London Medical Gazette,' vol. xxvii. p. 613.

coagula, the exact reverse of that usually observed, justified the opinion expressed before the facts of the case were known to Sir James, that the body had not been laid out in the usual manner.

Besides these discolorations caused by the blood which follows the course of the vessels, there are others due to transudation. Thus the parts in contact with the gall-bladder are deeply tinged with bile; and the eye shrinks from the transudation of the aqueous humour.

Putrefaction.—The chronological sequence of the phenomena characteristic of putrefaction, both externally and internally, has been minutely described by Casper, and may afford some indication of the time that has elapsed since death.

External phenomena.—The first sign in point of time is the well-known greenish discoloration of the abdomen. This may take place in from *one to three days* after death. Within the same period the eyeball becomes soft, and yields to the pressure of the finger. After *three to five days* the green coloration has become deeper, and spread over the entire abdomen, inclusive of the genitals, on which the colour is of a dirty brown, green appearance. At the same time large or small patches of green begin to make their appearance on other parts, particularly on the back, the lower extremities, the neck, and sides of the chest. Gas is developed in the abdomen, and in consequence a quantity of bloody froth begins to exude from the mouth and nose. In about *eight to ten days* the discoloration has become darker, and the strong odour of putrefaction is well developed. The abdomen is distended with gas. The cornea has fallen in and become concave. The sphincter ani is relaxed. In certain parts of the body the cutaneous veins are seen as red cords in the midst of patches of paler colour. *Fourteen to twenty days* after death, the body has become greenish-brown throughout. The epidermis has become raised and peeled off in patches. The abdomen and thorax are blown up. The cellular tissue is likewise inflated, so that the body has a gigantic appearance. The features are completely obliterated. The penis is enormously swollen. The nails are loose and easily detached. The hair is also loose and easily pulled out.

The subsequent progress of the putrefactive changes is very variable, according to the temperature and the medium in which the body lies. This fact is recognised by Casper, who states that a body far advanced in putrefaction, "at the expiration of one month, cannot with certainty be distinguished from one (*cæteris paribus*) at the end of 3-5 months."

The next stage is that of *Colliquative Putrefaction.*

The thorax and abdomen have burst open. The sutures of the skull yield. The orbits are empty, and the tissues generally have liquefied, and left the bones exposed. These ultimately separate from destruction of the ligaments.

Internal.—The internal changes first manifest themselves in the mucous membrane of the larynx and trachea, which, in from 3-5 days in summer, and 6-8 days in winter, becomes of a dirty cherry-red or brownish-red colour, and ultimately an olive-green.

The various organs putrefy with different degrees of rapidity.

The stomach putrefies at an early period. In from *four to six* days after death dirty-red patches appear on the posterior wall, and gradually extend over the whole interior. The mucous membrane becomes soft and pulpy. These changes are sometimes mistaken for the effects of corrosive poisons.

Next follow the intestines; then the spleen; after this, the liver, which, however, may remain firm and compact for some months after death. Putrefaction commences with a green colour in the diaphragmatic surface. The brain follows next. It collapses after death, and putrefaction commences in the line of the vessels, from without inwards, proceeding from the base. In *two to three* weeks it becomes quite diffluent. The brain of children, however, is the first organ to be destroyed by putrefaction. The heart and lungs resist putrefaction for a long period, and traces of disease are distinguishable in them long after other organs are quite decomposed. Orfila detected pneumonia 37, and signs of pericarditis 57 days after death. The kidneys resist putrefaction for a long time; the bladder, the œsophagus, and pancreas remain still longer. The diaphragm may be distinguished even after four to six months.

The uterus resists putrefaction longest of all. It still remains comparatively fit for examination when all the other organs are far beyond that state. It enables us to distinguish the sex after the complete destruction of all the other soft parts.

Casper relates a case where *nine months* after death the uterus was found in a fit state for examination, so that he could answer the question whether the deceased were pregnant at the time, and this after all the other viscera were completely gone, and the bones almost separated from each other by the process of colliquative putrefaction.

Modifications of the Putrefactive Process.—1. Saponification—Adipocere.—Instead of passing through the various stages above described, the tissues may become saponified, and be converted *into* the substance known as *adipocere.* This pecu-

liar transformation of dead bodies was first observed by Fourcroy, at the end of the last century, during the removal of bodies from the Cemetière des Innocens at Paris. Adipocere has an appearance intermediate between fat and wax, and hence the name given to it. It is a white or brownish, soft, unctuous substance, which becomes lighter and harder when dried. It consists of a union of fatty acid with ammonia, so as to form an ammoniacal soap. Occasionally the ammoniacal base may be replaced by calcium, so as to form a lime soap. This occurs especially in calcareous soils, and under the influence of water containing a large proportion of lime salts. It is supposed to be formed by the union of the ammonia given off by the decomposition of the tissues with the fatty acids of the decomposing fats.

There is no trace of structure in fully formed adipocere, though fragments of unsaponified tissue may be mixed with it. It remains for many years unchanged.

The formation of adipocere depends on the presence of fat; and hence it is found more particularly in the fatter parts of the body, and more readily the fatter the body. The bodies of children undergo the transformation into adipocere more easily than those of adults.

The presence of water is necessary for saponification. The process only takes place in bodies which have been lying in water or in a damp soil. The time required for saponification of a body is variously stated, and no fixed rules can be laid down regarding it. It was formerly wrongly supposed that a period of thirty years was necessary to cause the transformation. Devergie states that one year is necessary to cause the saponification of a body lying in water, and about three years if it is buried in a damp soil. Casper thinks that the formation of adipocere is not likely to occur to any considerable extent in less than three to four months in water or half a year in moist earth, though it may have commenced at a much earlier period. In some cases it may be observed in the space of five weeks in bodies floating in water (Taylor).

Rarely does the *whole* body become saponified; but many examples of this complete transformation were found among the large number of bodies disinterred while laying the foundations of King's College Hospital.

Mummification.—Another condition of the body may result under certain peculiar circumstances. Instead of undergoing colliquative putrefaction, or becoming saponified, the body *may* become dried up or mummified. The name sufficiently indicates the appearance which the body assumes. The whole body becomes

desiccated; so that the soft parts are retained, but are converted into a hard, dry, dusky-looking substance, closely adhering to the bones. The odour resembles old cheese more than that of putrefaction The change occurs when the body is subjected to conditions which rapidly abstract moisture from the tissues. Therefore bodies buried in the dry sands of the desert, or exposed to heat and currents of dry air, undergo this change. It is also said to occur in arsenical poisoning In this case the poison acts as an antiseptic, opposing the putrefactive changes; so that the *body* becomes preserved by the gradual process of desiccation. Occasionally a body is found so completely devoured by worms that nothing remains but bones, cuticle, and hair.

In attempting to draw any conclusions as to the time of death from the state of the *body* as regards the putrefactive process, it is necessary to pay special attention to the *external* and *internal* causes which affect the progress of putrefaction.

These are:—*External.*—Temperature, Moisture, and access of air; Period, Place, and Mode of Interment. *Internal.*—Age, Sex, Condition of the Body, and Cause of Death.

***Temperature.*—Putrefaction is arrested by a temperature of 212° and of 32°: in the former case the body is dried by evaporation; in the latter the fluids are congealed. The most favourable temperature is one ranging from 70° to 100°. Putrefaction, therefore, takes place more rapidly in summer than in winter, and, other things being equal, varies with the temperature.**

***Moisture.*—This is an essential condition, without which putrefaction cannot begin, or, having begun, cannot continue. The body contains, in all its parts, moisture enough to insure decomposition; but those parts, such as the brain and eye, which contain most fluid are most prone to putrefaction, and dropsical subjects putrefy speedily.**

Putrefaction also commences soon, and runs a rapid course, in inflamed parts, in bruises, and at the edges of wounds.

Bodies which have remained some time in the water, and are then exposed to the air, putrefy more rapidly than those that have not been immersed; but in bodies which remain in the water putrefaction goes on slowly, from the contact of air (a condition highly favourable to putrefaction) being prevented.

On the other hand, dryness of the air retards or arrests putrefaction. Hence the preservation of the bodies of travellers on sandy deserts. A rapid current of air has the same effect by promoting evaporation. But a moist and stagnant atmosphere encourages putrefaction, by retarding evaporation no less than by *supplying* moisture.

Access of Air.—That the presence of atmospheric air promotes putrefaction is shown by the slow development of gas that takes place when blood or flesh is introduced into a vessel through mercury, so as to exclude all the air which does not attach to the substance introduced; also, on the other hand, by the preservation of flesh in atmospheres not containing oxygen, such as hydrogen and nitrogen; less completely in atmospheres in which oxygen is chemically combined with some other gas, as in carbonic acid and nitrous acid; also in atmospheres filled with vapours that absorb oxygen, such as turpentine. Oxygen, taken separately, promotes putrefaction more than any other gas, but when combined with nitrogen, as in the atmosphere, its activity is greatly increased. But it must be remembered that the free access of air also affords the most favourable condition for the access to the body of the germs, which are now generally regarded as the active agents in the putrefactive process.

Heat, moisture, and free access of air, then, are the conditions most favourable to putrefaction; and in judging of the time at which death took place, we should well weigh the amount of influence each of these agents has brought to bear on the result.

Period, Place, and Mode of Interment.—Period.—Bodies putrefy much more speedily in air than in the ground. Hence the longer interment is delayed, the greater the changes they undergo. Thus, Orfila observes, that if, during summer, a body be exposed for five or six days, and then interred, it will have undergone at the end of a month as much change as it would have done at the end of seven months, had it been interred at once.

Site.—In dry elevated situations, putrefaction goes on slowly: in low swampy grounds, rapidly. *Soil.*—A dry absorbent soil retards, a moist one accelerates, putrefaction. In sand or gravel the change goes on slowly, and adipocere is rarely met with: in marl or clay, and in loose mould, especially that which is impregnated with animal or vegetable matter, more quickly (except peat, which retards putrefaction). The deeper the grave, *cæteris paribus*, and the more completely the body is defended from the air by clothes or coffin, the slower the putrefaction. It is rapid where the body is in contact with the soil, but very slow where it is buried in a coffin hermetically sealed.*

Age.—Other things being equal, the bodies of children putrefy

* Consult Orfila's 'Traité des Exhumations Juridiques,' and Devergie's 'Médecine Légale,' which contains the marrow of Orfila's observations, with his own account of the changes produced by putrefaction in the water. See also Casper's Handbook, vol. i. p. 30.

more speedily than those of adults and aged persons, and the bodies of old persons more rapidly than those of adults.

Sex.—According to Orfila, putrefaction is more rapid in women than in men. He attributes this to the greater quantity of fat which they contain, an explanation which, though not quite satisfactory, agrees with the fact that the corpulent putrefy more readily than the lean and emaciated. Casper, who disputes the influence of sex, observes that the bodies of women dying during, or soon after child-birth, putrefy very rapidly.

Condition of Body and Cause of Death.—Putrefaction takes place most speedily in bodies filled with fluid. Accordingly, it is very rapid after sudden death, and death from acute disease (*e.g.* 15 hours in a woman dying from hydrophobia in mid-winter —Sauvage); slower after death from hæmorrhage, and from chronic disease, unless complicated with dropsy, or extensive structural change, as in typhus, and typhoid fevers, small-pox, erysipelas, &c.

What is true of the entire frame, is true also of parts of the body; for those which are full of fluid at the time of death, through inflammation, congestion, or dropsy, wounds or bruises, putrefy more rapidly than healthy and entire structures. In some instances, as in low fevers, putrefaction attacks the extremities before the trunk has ceased to live.

It was formerly believed that the bodies of persons destroyed by poison putrefied very rapidly; but this is now known to be a mistake. Casper specifies phosphorus, alcohol, and sulphuric acid, as poisons that retard putrefaction, and though he classes smoke and carbonic acid with sulphuretted hydrogen and narcotic poisons, as hastening it, it appears from three cases reported by Devergie, that in death by carbonic acid the process is decidedly retarded. Arsenic, and the other mineral poisons, act as antiseptics. Animal and vegetable poisons have probably no effect either way; but persons killed by them putrefy rapidly, as in other cases of speedy death. There is reason to believe that putrefaction takes place with unusual rapidity in animals driven soon after a meal and dying suddenly; in men dying suddenly during violent exertion and in soldiers killed late in battle.

Putrefaction in Water.—More dependence is to be placed on the criteria laid down for determining the period of death of bodies which have remained in the water, than of those exposed to the air or interred, for the obvious reasons, that the temperature of the water is more uniform, and the body, unless when it rises to the surface, is protected from the air. As Devergie, whose official position at the Paris Morgue has given him unusual

means of observation, places much reliance on the signs by which the period of death is determined in the drowned, the following account based upon his description is subjoined:—

The bodies of the drowned are subject, like those who perish in other ways, to loss of heat and rigidity, and to putrefaction, but in a modified form, accompanied by the formation of adipocere. One of the first changes, which may be seen as early as the *third or fourth day*, consists in bleaching of the skin of the hands. *At the end of a week* the body is found supple, and the skin of the palms of the hands very white. *A week to twelve days* of immersion bleaches the backs of the hands, and softens and bleaches the face. *At the end of a fortnight* the hands and feet are bleached and wrinkled, the face slightly swollen with spots of red, and the middle of the sternum has a greenish tint. *At the end of a month* the hands and feet are completely bleached and wrinkled as if by a poultice, the eyelids and lips are green, the rest of the face reddish-brown, and the front of the chest presents a large patch of green with a reddish-brown spot in the centre. *At the end of two months*, the face is swollen and brown, and the hairs are but slightly adherent: much of the skin of the hands and feet is detached, but the nails have not separated. *At two months and a half* the skin and nails of the hands are detached, and the skin of the feet, but the toe-nails still adhere. In the female, reddish discoloration of the subcutaneous cellular tissue of the neck, of that which surrounds the trachea, and of the organs contained in the cavity of the chest; partial saponification of the cheeks and chin; superficial saponification of the mammæ, the axillæ, and the anterior part of the thighs. *At three months and a half*, the skin and nails of the hands and feet completely removed; part of the hairy scalp, of the eyelids, and of the nose, and the skin of many parts of the body destroyed; and the face and upper part of the neck and axillæ partially saponified. *At four months and a half*, nearly total saponification of the fat of the face, of the neck, of the axillæ, and of the anterior part of the thighs; commencing earthy incrustation of the thighs; incipient saponification of the anterior part of the brain; opaline state of the greater part of the skin; almost entire separation and destruction of the hairy scalp; calvarium denuded and beginning to be very friable.

As to more remote periods no accurate approximations can be given; but Devergie alleges that the above signs have been repeatedly applied with complete success to bodies that had been in the water for unknown periods.

The foregoing description applies to bodies immersed during

winter. Bodies immersed in summer undergo the same changes much more rapidly. Thus, 5 to 8 hours in summer correspond to 3 to 6 days in winter; 24 hours to 4 to 8 days; 48 hours to 8 to 12 days, 4 days to 15 days. Thus on the average the same changes in summer take place from three to five or six times as rapidly as in winter, or even more promptly than that, the changes in spring and autumn being intermediate.

That development of gas within the body which causes it to rise to the surface, takes place slowly in winter, and the body rarely floats in less than six weeks or two months. But the same change takes place in summer from the 14th to the 16th day, or even earlier. In some instances the body becomes buoyant at a much earlier period than either of those now indicated.

Of the subject of putrefaction generally, as a means of fixing the period of death, it should be observed that it is, from the nature of things, surrounded with difficulties, in consequence of the many elements that must have combined to produce these changes in the body. So that we read without surprise the following statements:—"On the 20th March, 1848, I examined the bodies of fourteen men, almost all of the *same age*, 24–30 years, previously occupying precisely the *same social position* (workmen of the lowest class), all lying together in the *same* part of our dead-house, who had all met the *same* death, having been shot on the barricades on the 18th of March, and had all notoriously died at the *same* time." "And yet I can testify that in no one case did the signs of putrefaction resemble those of another." (Casper's Handbook, vol. i. p. 33.) "An old couple of about the same age, 50–60 years, were suffocated during the night by carbonic acid gas. Up to the time of our examination, these bodies had been exposed to precisely similar influences, and yet, on the fourth day after death (in November), the body of the man was quite green, both on the abdomen and the back, and the trachea was brownish-red from putridity, &c., while his uncommonly fat wife was perfectly fresh both outside and in." (Ibid. p. 34.) In the face of facts like these, we find both French and German authors speaking with much confidence of the value of the signs of putrefaction; and Casper himself stating that at a similar average temperature putrefaction in the open air, in water, and in a coffin, will have advanced equally after the lapse of one, two, and eight months respectively.

SUDDEN DEATH.

That cases of sudden or speedy death are not uncommon may be *inferred* from the fact, that upwards of 3000 sudden deaths

occur year by year in England and Wales from causes not ascertained, over and above the 15,000 returned as due to violent causes, of which the greater number also belong to this class. Though it may not always be possible to ascertain the true cause of death, some advantage may arise from a discussion of some of the common causes of sudden and speedy death, coupled with some account of those appearances in the body which are most characteristic of different modes of dissolution.

A temporary suspension of the heart's action is the chief sign, of apparent death; a total arrest of its contractions is real death. Some vital endowments of the blood and muscles survive this cessation of the circulation; and the lingering irritability of the heart itself, and especially of the right auricle, forms our ground of hope in using means of resuscitation. This suspension or total arrest of the heart's action, or, in other words, apparent or real death, may be brought about by different causes of which some act directly on the heart, others indirectly through the lungs.

The causes of sudden death which act directly on the heart are —1. *Structural diseases of the heart itself, and of the large vessels.* 2. *Nervous shocks paralysing its muscles.* 3. *Causes cutting off its supply of blood.* 4. *Causes destroying the stimulant property of the blood.*

1. The structural diseases of the heart and large vessels—hypertrophy, valvular disease, aneurism, and ossification of the heart, aorta, or coronary arteries—are readily discovered on post-mortem examination. But there is reason to believe that atrophy and fatty degeneration of the muscular tissues of the heart are occasionally overlooked. In two cases related by Sir James Paget, death really due to fatty degeneration was believed to have been caused by poison.

2. The nervous shocks of sufficient force to paralyse the heart, and to occasion instant or speedy death, may be caused by strong and sudden emotions of fear and joy, by lightning and the sun-stroke, by heavy blows on the head or pit of the stomach, by violent exertion causing sudden effusion of blood on the brain (of which one case has come under our notice), by large drafts of cold water swallowed when the body is heated, and by a few of the more active poisons in full doses.

3. The supply of blood necessary for the heart's action may be cut off by profuse hæmorrhage.

4. The proper constitution of the blood may be destroyed mechanically by the admixture of air introduced into the veins during operations on the neck, shoulder, or axilla; and chemically

by poisons directly introduced into the circulation. This contamination of the blood plays an important part in death by all active and deadly poisons, whether inhaled or swallowed.

Of the causes of sudden or speedy death which act indirectly on the heart, the most common is that arrest of circulation through the lungs which attends the several forms of suffocation. A similar arrest is the intermediate link between the less severe nervous shocks, and the ultimate arrest of the heart's action.

Several of the foregoing causes of sudden death are at once revealed by a careful inspection of the body; but those which have not given rise to any structural change may yet occasion such marked changes in the distribution of the blood through the body, and in and about the heart, as to aid us in our inquiries into the true cause of death. Thus, death from the rapid loss of blood would be indicated by pallor of the surface, and the empty and contracted state of all the cavities of the heart; death from shock suddenly arresting the circulation, by a distended state of all the cavities; and death from suffocation by violet patches on the surface, and distension of the right side of the heart with dark blood.

The causes of sudden death, and the post-mortem appearances by which they are indicated, may be more fully discussed by adopting the well-known classification of Bichat—namely, death beginning at the *head*, *heart*, and *lungs* respectively.

Sudden Death commencing at the Heart.—Syncope.—The phenomena which attend this form of death are:—Pallor of the face and lips, cold sweats, dizziness, dimness of vision, dilated pupils, gasping and sighing respiration, a slow, weak, and irregular pulse; to which are sometimes added nausea and vomiting, restlessness and tossing of the limbs, transient delirium and convulsions. On inspecting the body, the vessels generally are found to contain little blood, and the heart to be nearly or quite empty, and contracted. This empty state of all the cavities of the heart contrasts strongly with their distended state in the rare cases of death originating in the brain, and acting directly upon the heart; and not less strongly with the distended condition of the right side of the heart, and empty state of the left, which occurs in death commencing in the lungs.

Sudden Death commencing at the Head.—Injuries to the nervous centres may act directly on the heart, and stop its contractions: or they may first affect the respiration by paralysing the respiratory muscles. When the heart is directly affected, the circulation is, as it were, arrested and fixed in what may be termed its normal state, each side of the heart containing its due

proportion of blood, and all the cavities being distended from its sudden loss of power to propel its contents. This mode of death has been designated *asthenia*. When, on the contrary, the muscles of respiration are paralysed, the post-mortem appearances will be those presently to be described under the head of apnœa.

Sudden Death commencing at the Lungs (*Asphyxia*).—The term asphyxia, literally taken, means pulselessness. It is now understood to mean real or apparent death due to a suspension of the function of respiration,—a mode of death much better defined by the term *apnœa*,* of which the following are the chief causes:—1. *Cessation of the action of the muscles of Respiration.* 2. *Cessation of the action of the Lungs themselves.* 3. *Exclusion of air from the Lungs.*

1. *Cessation of the Action of the Muscles of Respiration* may be due to *inertia* of the muscles themselves, from cold or debility; to *a loss of nervous influence*, as from division of the upper part of the spinal cord, or of the pneumogastric and phrenic nerves; from the lightning stroke, and from apoplectic seizures; to *mechanical restraint*, as by pressure on the chest or abdomen; or to *tonic spasm*, as in death from Tetanus or Hydrophobia.

2. *Cessation of the Action of the Lungs* may be due to a division of the eighth pair of nerves; or to a mechanical obstacle, such as the admission of air into the pleuræ, or the intrusion of the abdominal viscera through a wound in the diaphragm.

3. *The partial or complete Exclusion of Atmospheric Air from the Lungs* may be brought about by the entire absence of air, as in a vacuum; or by its extreme rarefication, as on the top of very lofty mountains. The air, again, may be mechanically excluded, by a foreign body in the larynx, by submersion, suffocation, strangulation, or suspension. Lastly, the place of the atmospheric air may be taken by an irrespirable gas, such as nitrogen or hydrogen. There are other gases which exercise a deleterious influence, independent of the exclusion of air. Of these some are intensely irritating, as the sulphurous acid gas, chlorine, and ammonia; others, though less irritating, are not less fatal, such as carbonic acid, carbonic oxide, carburetted hydrogen, nitrous acid, hydrosulphuric acid, hydrosulphate of ammonia, arseniuretted hydrogen, and the vapour of hydrocyanic acid. These, as well as the simply irritant gases, may act mechanically by causing spasmodic closure of the glottis.

To this list of the causes of apnœa may be added certain dis-

* The term apnœa has been applied by physiologists to the cessation of respiration when the blood is kept oxygenated by artificial means. This double meaning is inconvenient. *The term is here* used in the old sense of asphyxia.

cases of the lungs, as hepatization, œdema, or tubercular infiltration, which fill the air-cells, and prevent respiration.

The *symptoms* of apnœa are more or less strongly marked according as the asphyxiating cause acts suddenly or slowly. If the air is suddenly excluded, as by mechanical compression of the trachea, complete submersion, or the inhalation of a gas which causes spasmodic contraction of the glottis, the symptoms are urgent, and run a rapid course. The sufferer struggles violently for breath, and uses strong efforts to remove the obstruction. The face flushes, and soon grows turgid and livid; the veins of the head and neck swell; the eyeballs start from their sockets; and the swollen tongue protrudes between the teeth. A short attack of giddiness, with bright spots before the eyes, and ringing sounds in the ears, is followed by loss of consciousness, convulsions of the limbs, and relaxation of the sphincters, with expulsion of the prostatic fluid, of the urine, or of urine and fæces. In two or three minutes, if relief be not given, life is extinct.

When the asphyxiating cause acts more slowly, the symptoms are modified, and succeed each other at longer intervals. There is a feeling of constriction in the chest, from which the sufferer tries to free himself by strong voluntary efforts to inspire, or by the involuntary efforts of yawning or sighing. A dull heavy pain in the forehead, with giddiness, dimness of sight, and torpor of the intellect succeeds, and gradual loss of sensation and voluntary motion. Still, the functions of respiration and circulation continue, as shown by almost imperceptible movements of the walls of the chest, and pulsations of the heart scarcely sensible to the hand. This imperfect state of respiration and circulation is followed by the entire cessation of those functions, and by complete loss of motion, voluntary and involuntary. At this point of time the fulness of the capillary system begins to show itself, by a deep violet discoloration of the face, which also extends to the hands and feet. Some portions of the trunk and extremities exhibit spots more or less extensive, of the same colour. At length, the capillary circulation ceases, and the state of apnœa is complete.

In some cases, the asphyxiating cause, acting more slowly still, induces a sleep which terminates, without suffering, in death: in other instances, the sensations are even pleasurable, consisting of a display of beautiful colours or of pleasant landscapes before the eyes. There is still another class of cases in which the sufferer, suddenly roused from a state of torpor to a vivid and painful perception of his state, tries to escape from the death which

threatens him, but his strength fails, and he falls to the ground.

The post-mortem appearances are the following:—Patches of rosy, bright red, or violet discoloration on the face or on other parts of the body, as much on the least as on the most depending parts. The eyes usually prominent, firm, and brilliant. The mouth in some cases expressive of calmness, in others of suffering. Cadaveric rigidity strongly marked and persistent. The venous system of the brain commonly full of blood, but its substance presenting, when divided, few bloody points. Sometimes the ventricles contain serum; sometimes blood is effused at the base, in the substance, or on the surface, of the organ. The base of the tongue is almost always injected, and its papillæ are strongly developed. The lining membrane of the epiglottis, larynx, and trachea, of a deep red colour, becoming more intense as we approach the last ramifications of the air-tubes. The air-passages often contain a bloody froth. The *lungs* are so much distended and enlarged as to project over and conceal the pericardium. They are of a deep violet colour, and when cut into and compressed, large drops of black, thick, liquid blood exude. The liver, spleen, and kidneys, are also gorged with blood. The veins of the heart are distinctly traced on its surface, its right cavities and the large venous trunks are gorged with black, thick, liquid blood; but its left cavities are found nearly or quite empty.

Such are the appearances present in death by apnœa in its unmixed form; as in death by carbonic acid. But they are not all present in every case, nor, if present, equally marked in all.

Theory of Apnœa (*Asphyxia*).—When air is prevented from reaching the lungs, the blood does not undergo its usual change from venous to arterial; and venous blood does not support the vital functions of the several organs so completely as arterial blood does. Some, indeed, have supposed that venous blood is a positive poison; so that it is much worse for an organ to be supplied exclusively with venous blood than to receive no blood at all.

On this assumption, the cessation of the heart's action may be explained in one of three ways:—By the circulation of venous blood through the coronary arteries in place of arterial blood; by the venous blood failing to excite the left cavities of the heart to contraction; or by the nervous centres, in consequence of the circulation of venous blood through them, failing to supply the requisite motive power.

Whether venous blood is directly poisonous, and worse than no blood at all, has been the subject of numerous experiments.

Kay has shown that it has no deleterious influence on the muscles, by comparing the contractility of a limb from which the supply of arterial blood has been cut off with that of a limb supplied exclusively with venous blood; and Edwards found that a cold-blooded animal lives longer in an asphyxiating medium than one whose heart and bulb of the aorta have been excised.

As the absence of all circulation through the vessels of the heart, or through those of the brain, or through the nerves supplying the heart with vital stimulus, would certainly and speedily destroy life, so would the mechanical exclusion of arterial blood from the vessels of those parts, whether by warm water or by venous blood. This theory of exclusion, then, is adequate to the explanation of death by apnœa. But whether the excess of carbonic acid, or absence of oxygen, or both together, be the true cause of the symptoms, the essential character of this form of death consists in the accumulation of blood in the lungs and right cavities of the heart, leading to a diminished supply to its left cavities and a gradual cessation of the circulation. Hence in death by apnœa the left ventricle is found contracted, and nearly or altogether empty. The proximate cause of this arrest of circulation through the lungs is of little importance; the fact is all with which, as medical jurists, we have to do.

On contrasting the post-mortem appearances proper to the three modes of death, syncope, asthenia, and apnœa (asphyxia), it will be seen, that in the first, all the cavities of the heart are empty, or contain little blood; in the second all the cavities are full; and in the third, the right side is gorged with blood, while the left ventricle contains little or none.

It should, however, be borne in mind that the characteristic appearances of sudden death, due primarily to the heart, the lungs, or the brain, are not always equally marked; that they may be combined with each other in different proportions: and that a cause usually productive of the one may give rise to the other. Thus, a man may be threatened with suffocation (one cause of apnœa), and fright may give rise to sudden *syncope*; or a violent attempt to escape may burst a blood-vessel in the brain, and cause *apoplexy*.

The following facts relating to sudden death are taken from the 19th Annual Report of the Registrar-General. Of 416,470 deaths from all causes, occurring in England and Wales, on the average of the five years 1852-56, 13,711, or about 1 in 30, were violent deaths, of which 3045 were due to various forms of chemical injury, 3826 to apnœa (asphyxia), and the remaining 6840 to various mechanical injuries. Of the 13,711 violent

deaths, 10,057 occurred in males, and 3654 in females. The sudden deaths, for the average of the same five years, are stated at 3843 or nearly 1 per cent. (1 in 109). They are distributed between males and females in the proportion of about 3 to 2.

The suicides on the average of the same five years amounted to 1083, of which 777 were men and 306 women. Of 1044 due to ascertained causes, 642 were by various forms of suffocation, 111 by poison, 1 by burning, and the remainder by mechanical injuries, among which 210 cut throats, 43 gun-shot wounds, 12 other wounds, and 20 falls. The suicides by poison of men and women respectively were as 6 to 5, by apnœa as about 3 to 1, and by mechanical injuries as about 4 to 1. The greatest number of suicides in both sexes occurred between the ages of 45 and 55.

The relative frequency of the several forms of sudden death appears, from a work of Ferrario and Sormoni on sudden deaths (1048 in number) occurring in Milan, to be as follows:—

Head (apoplexy, cerebral concussion, vertigo, and coma)	879 or about 4 in 5.
Heart (diseases of the heart, angina pectoris, aneurism, and hæmorrhage)	150 or about 1 in 7.
Lungs (asphyxia, suffocative catarrh, and pulmonary apoplexy)	14 or about 1 in 75.
Difficult labours	5

The relative frequency of the different forms of sudden death classified according to their proximate causes must, however, be understood to differ at different periods of life. The above proportions are obviously those that obtain chiefly among adults; for sudden deaths in infancy and childhood, if classed according to their causes, would reverse the order just stated. By far the most frequent cause of death in infancy and childhood is to be found in the lungs, and the least common in the brain; though the fact of convulsions being very common in early life might lead to the inference that the majority of sudden deaths originate in the brain, and not in the lungs. The diseases of the lungs which give rise to sudden or speedy death in infants and young children are spasmodic croup or laryngismus stridulus, to which Dr. West attributes three out of four of the sudden deaths of children under one year, imperfect expansion of the lungs at birth (atelectasis pulmonum), sudden collapse of the lung, consolidation from pneumonia, and sudden serous effusion into the pleura, to which ought to be added a disease not mentioned in the paper now referred to, pulmonary apoplexy. A not uncommon cause of sudden death among the children of the poor is suffocation, as a consequence of drinking hot water from the spout of the kettle.

Next to diseases of the lungs, sudden death by exhaustion from insufficient food, or chronic diarrhœa, is most common, while fatal disorders of the brain are very rarely to be set down among the causes of sudden death in infancy and childhood.* Of the sudden deaths entered in the tables of the Registrar-General upwards of one-third occur in infancy.

SURVIVORSHIP.

When two or more persons die by the same accident, a question may arise as to which died first; for, in certain cases, the succession to property would be secured on proof of survivorship even for an instant.

Little has yet been done towards establishing general principles applicable to this class of inquiries, chiefly from want of the requisite materials. Some of the more accurate results which have been attained will be found stated under the following heads:—1. *Of the probabilities afforded by age and sex, irrespective of the mode of death.* 2. *Of the degree in which such probability is affected by the mode of death.*

I. OF THE PROBABILITIES AFFORDED BY AGE AND SEX.

Age.—As the body attains its full growth and strength at about 27 years of age, or from 25 to 30, and healthy persons continue strong and vigorous up to about 50, there will be no sufficient ground for inferring survivorship in the case of adults of the same sex, whose ages range between 25 and 45, or even between 20 and 50, provided the form of death be one in which mere strength and power of endurance is concerned. Before and after the ages specified, these will be less; but still within the limits of puberty and old age (say 15 and 60 years) the difference will probably be inconsiderable. The probability of survivorship, in the case of a middle-aged adult perishing with one under puberty or above 60, will be in favour of the adult. In the case of one under 15 and one above 60 perishing together, the French law assumes that the former survived: when both are under 15, that the elder outlived the younger. According to the civil law of England, if parent and child perish by a common death, the child is presumed to have survived if above, and to have died first if under, puberty.

In the case of a mother and child both dying in childbed, without assistance, the presumption is, that the mother survived;

* See a Lecture by Dr West, on Sudden Death in Infancy and Childhood, in the 'Medical Times and Gazette,' Nov. 26, 1859.

for there is a chance of still birth, and a further probability that the child, if born alive, would die before the mother could render it the assistance necessary. A large child would be still more likely to perish first, for, as elsewhere stated, still-born children greatly exceed in size and weight those born alive. If the child's body could be examined, the presumption might be strengthened by the marks of a difficult labour, or the absence of the signs of respiration. Legal decisions have not always been in conformity with the principle here laid down.

Sex.—If a male and female perish by a common accident, in which strength and courage give the best chance of safety, it may be inferred that the male, being the stronger, is the survivor. But females, being subject to prolonged faintings from fright, may be, by that very circumstance, incapacitated from those struggles which in so many forms of death may be presumed to increase danger. When, then, there is safety in exertion, the probability of survivorship will be with the male; when in passive endurance or insensibility, with the female.

II. OF THE DEGREE IN WHICH THE FOREGOING PROBABILITIES ARE AFFECTED BY THE MODE OF DEATH.

Under this head some common modes of death will be specified, and an attempt will be made to establish some general principles with respect to them, assuming, as before, that the parties about whom the question is raised are placed, as nearly as may be, in the same circumstances.

Apnœa (*Asphyxia*).—Women consume less oxygen than men; hence the same quantity of air will last them for a longer time; and of adult males and females perishing together by apnœa, the females may be presumed to have survived. In poisoning by carbonic acid gas, which is nearly allied to death by apnœa, the chances of survivorship are with the female. This statement rests on the authority of a large number of facts. In 19 out of 360 cases of poisoning by carbonic acid, which took place in Paris during 1834 and 1835, a man and woman were exposed to the fumes of charcoal together: of these, three only were saved, and these were females. In solitary cases of the same form of death the result is also favourable to the female; for 18 out of 73 females were restored, and only 19 out of 83 males, so that the chances for the female and male respectively are nearly as 15 and 14 (instead of 5 and 4 as Devergie represents it). Single cases are in conformity with this result. Thus, in a case quoted by Beck from the 'Transylvania Journal,' a man and his wife were exposed in a small room to the gas from live

coals. The man was found dead, rigid, and contracted, but the woman was still breathing, and recovered. Again, in a case reported by M. Bardaillon, a man, his wife, and their child, aged seven years, were asphyxiated in a porter's lodge. The child died, the father was very ill, and with difficulty restored to life, while the wife was able to call for help and to assist both husband and child. In these cases it is necessary to take into account the position which the parties occupied in the room, whether on the bed or on the floor, near to or remote from an open window, &c.

Drowning.—There are many complicated considerations connected with this mode of death. In shipwrecks men are more likely to be in a favourable situation for saving themselves, as they are more on deck than women, less encumbered by clothing, more likely to be able to swim, or to cling to floating portions of the wreck. When the comparison is between men similarly exposed and capable of the same exertion, it may be necessary to inquire whether one was more exposed to cold by having the body half immersed, while the other was more under water. Search should also be made for severe injuries which may have prevented the swimmer from using his strength, or may have otherwise proved fatal. Apoplexy is stated by Devergie to be sooner fatal than apnœa, while in death by syncope there is the best chance of recovery.

Suffocation.—In all cases of suffocation depending upon an insufficient quantity of air, or upon air rendered partially unfit for respiration, it may be presumed that those who require least air live the longest—women longer than men, children than adults. In suffocation from the falling of houses or earth, or by mechanical means in general, the stronger may be presumed to survive the weaker—men, women; adults, children and old persons.

Cold.—As young children bear cold worse than adults, the probability of survivorship in exposure to the same degree of cold is in favour of the latter. Men bear cold better than women, adults better than the aged. It is necessary also to take into account the clothing of the exposed persons, and their state of health. Spirituous liquors in excess increase the effect of cold.

Heat.—The young and old, as they suffer more from cold, so do they bear heat better. The relative tolerance of heat of the two sexes is not well ascertained. Foderé relates the case of an Englishman and his daughter aged seven years, who, in the year 1814, crossed the desert of Syria to the Persian Gulf. Both rode on camels, and were placed in precisely similar circumstances, but the father died, while the child arrived safe at its journey's

end. This result might, however, be explained by the greater exertion which the parent would be called upon to make.

Hunger and Thirst.—Those who have not reached their full growth require more nourishment than adults, and adults more than aged persons. The aged, then, if healthy and robust, may be presumed to survive both, and the adult to live longer than the child. Corpulent persons are thought to bear hunger better than the emaciated. In death from starvation, those who have the freest access to water may be presumed to live the longest. Those who use the greatest exertions will suffer earliest in this as in the foregoing modes of death. Those who possess most passive endurance may be expected to live the longest.

Such are some of the principal forms of death, in which the circumstances of the several victims are likely to be so similar as to admit of the application of general rules. In other modes of death, and in these under certain circumstances, there may be no points admitting of strict comparison, and many things which may exercise a marked influence on the result will have to be taken into account. The reader will find several such cases quoted in Beck's 'Medical Jurisprudence;' but as they throw little light upon the general question, and establish no fixed principles, they are not quoted here.

It has been suggested that a distinct enactment would be preferable to the present custom of deciding each case on its own merits. Such an enactment, extending to that large class of cases in which the circumstances of the death are but imperfectly known, and to those in which it is in the very nature of things impossible to come to a correct decision, is certainly much to be desired.

CHAPTER II.

DROWNING—HANGING—STRANGULATION—SUFFOCATION.

These modes of death are brought together in the same chapter, as they are all forms of apnœa, or death beginning at the lungs.

DEATH BY DROWNING.

The medico-legal importance of this subject may be inferred from the fact, that on an average of the five years 1852–56, 2352 deaths were caused by drowning, of which 1847 in males and 505 in females. Of this number 164 (87 males and 77 females) were ascertained acts of suicide. In 1871 the numbers were:—males, 2348; females, 574. Total, 2922. Of which, by suicide:—males, 173; females, 144.

Death by drowning is commonly attributed to apnœa; but as it is not always due to that cause, it will be necessary to describe the various modes in which a man who has died in the water may have come by his death.

When a man in perfect possession of his faculties falls into the water, he sinks to a greater or less depth, but immediately rises to the surface again; and, if he is a swimmer, makes efforts to save himself, till at length he is reduced to the condition of one who cannot swim at all; with this difference, that he has already exhausted the strength which the other has in reserve for the death-struggles common to both. These struggles consist of irregular movements of the arms and legs, and graspings of the hands at all objects within reach, whether floating in the water, fixed at the bottom, or growing on the banks. In the course of these irregular movements he rises repeatedly to the surface, tries to breathe, and takes in air and water. The contact of the water with the windpipe causes a cough, by which part of the *fluid* is rejected, and with it some air from the lungs. This occurs again and again, till the body no longer rises to the

surface; water alone is received in the vain efforts to respire, while forcible involuntary expirations continue to expel air from the chest. At length all these efforts cease, the body sinks to the bottom, and bubbles of air are forced from the chest by the elastic reaction of its parietes. The greater part of the water which has entered the mouth finds its way into the stomach, the rest into the lungs; and this residue, mixed with the secretions of the mouth and air-passages, and frothed by the air inspired and expired, forms the foam so constantly met with in persons who have perished in this way.

In these cases we may expect to find the characteristic marks of apnœa, coupled with those due to the medium in which the death takes place. In the case of the swimmer death may take place from exhaustion, with less distinct signs of death by apnœa.

But death may take place in the water, and yet be caused neither by apnœa, nor by exhaustion. There may be complete loss of consciousness at the very moment of immersion. This may happen from fright, from drunkenness, from an attack of hysteria, or of catalepsy (of which we have known one instance); and in this case the body falls to the bottom, rises again to a certain height, and sinks without a struggle. In these cases death is due to shock, or to syncope.

Again, a man may fall, or throw himself into, the water head foremost, and, striking against a rock or fragment of wood, or even against the water itself, perish by concussion; or falling, or being thrown, from a height, may strike the water with the chest and pit of the stomach, so as to cause instant death from shock.

Again, cold, excitement, or the first violent struggles, may occasion apoplexy, or sudden death from disease of the heart. These sudden deaths by diseases of the brain and heart are of occasional occurrence in persons bathing in cold shallow water.

Death by drowning may also be of a mixed character. A man falls into the water in full possession of all his faculties, which he preserves for a time, till, struck with horror at the death which threatens him, he faints, and thus perishes.

It appears, then, that death by drowning may be due to apnœa, o exhaustion, to shock, to syncope, and to apoplexy; or partly o apnœa, partly to one of the other causes just specified. The ses in which there exist marks of apnœa more or less distinct ended with those proper to some other form of death, are much e most common; while those in which the signs of apnœa are olly absent form a *small* minority, and cases of pure and

unmixed apnœa occupy an intermediate place. Devergie, whose large experience of the drowned has been already alluded to, estimates the cases of unmixed apnœa as *two in eight* of the whole, the cases in which no traces of apnœa exist as *one in eight*, and the mixed cases as *five-eighths*.

The appearances in the body of the drowned must necessarily vary with the manner and cause of death.

In those cases in which death has been due to *apnœa*, the post-mortem appearances will be those proper to that mode of death (see p. 251), blended with those due to the medium in which the death happened, and modified by the time the body has remained in the water, as well as by the length of subsequent exposure to the air.

If the death was due to apnœa, and the examination was made soon after the death and removal from the water, it may be expected to present the following appearances: The face and general surface of the body are either pale or slightly livid, with patches of a deeper tint. The expression of the face is generally calm. The tongue is swollen, and closely applied to the teeth, rarely protruded between the closed jaws, and still more rarely wounded and bloody; and there is a frothy foam at the mouth. The air-passages also contain a froth, which is sometimes tinged with blood; and the trachea and larger bronchial tubes contain water, which sometimes penetrates to their most minute ramifications, and may be in such quantity as to fill the whole of the air-passages. The water occasionally carries with it portions of slime or mud, or fragments of aquatic plants. The lining membrane of the air-passages is sometimes congested; the lungs contain a large quantity of black fluid blood, which also distends the venæ cavæ and right side of the heart, while the left cavities and aorta are comparatively empty. The stomach almost always contains water, sometimes in considerable quantity. The intestines have a rosy colour; the liver, spleen, and kidneys are gorged with blood; and the bladder sometimes contains bloody urine. The brain presents the same appearances as in other cases of death by apnœa. Sand or mud is often found in the hollow of the nails, the fingers are sometimes abraded, and portions of plants growing in the water, or on the banks of the stream, may be found grasped in the hands. Injuries received in falling into the water during the death-struggles, or through the violence of the stream, may also leave their marks upon the body.

In bodies that have remained in the water, or been exposed to the air for some time, the pallid, or slightly livid hue of the features may be exchanged for a bloated appearance, and large

livid spots may show themselves on different parts of the body as in other cases of death by apnœa.

In death by shock, syncope, or exhaustion, there is little or no water in the air-passages or stomach. The cavities of the heart and the large vessels are equally distended with blood, or are nearly empty, and the brain and internal viscera are in their natural state.

Death by concussion or by apoplexy, or by disease of the heart, reveals itself by the usual post-mortem appearances.

In mixed cases, the appearances due to apnœa will be less strongly marked. There will be less froth at the mouth, less water and froth in the air-passages and stomach; less congestion of the lungs, heart, and great vessels, and internal viscera.

Several medico-legal questions suggest themselves in reference to a body found in the water. The first in order is the following: —*Was death caused by drowning?* In the case of a body found in the water, death may obviously have happened prior to immersion from natural causes or from intentional violence; and in the latter case the death may have been due to some cause producing apnœa, and giving rise to the characteristic appearances proper to that mode of death. In other words, a person may be strangled or suffocated, and then thrown into the water to conceal the true cause of death. In deciding a question of so much difficulty, we shall have to consider whether the post-mortem appearances alleged to be characteristic of death by drowning might have been occasioned by causes acting before immersion; also whether, in the case of bodies remaining in the water some time after death, the appearances usually attributed to the mode of death may not be explained by the circumstances of the immersion itself.

Of the post-mortem appearances present in the bodies of those who have perished by drowning, some are proper to that mode of death, others common to death by other forms of apnœa. To the latter class belong the position and swollen state of the tongue; the pallor with rosy or violet discolorations of certain parts of the skin; the injected state of the brain; the congestion of the internal viscera; the greatly increased volume of the lungs; the fulness of the right cavities of the heart, and emptiness of the left; the fluid state of the blood; and the existence (very rare) of bloody urine in the bladder. To the former class belong:—excoriations of the fingers, with sand or mud in the hollow of the nails; fragments of plants grasped in the hand; water in the stomach; froth at the mouth and nostrils; froth, water, mud, or sand in the air-passages; and retraction of the penis.

Of the appearances common to drowning and to death by other forms of apnœa, all that can be said is, that their presence in persons found dead in the water is consistent with the supposition of death by drowning.

The post-mortem appearances alleged to be due to drowning, and to be characteristic of it, must now be briefly considered.

Excoriations of the fingers are much more often absent than present; but, when they exist, may be regarded as a probable, though not certain, sign of death by drowning. They might be caused previous to forcible immersion, by the rubbing of the fingers against any hard and rough body; and possibly after death in running streams.

Sand or mud in the hollow of the nails, also, affords a probability of immersion during life, for it implies, like excoriations of the fingers, that the drowning man grasped at the bed or banks. But if the body remained long in the water, mud or sand might be deposited in the nails.

Hands clenched and *grasping weeds growing in the stream or on the banks*, afford the strongest probability of death by drowning.

Water in the Stomach.—The discovery of water in the stomach also affords strong presumption in favour of death by drowning; especially if the water (or other fluid) can be identified with that in which the body was found by its containing leaves of plants growing on the banks or at the bottom. Except in the cases presently to be mentioned, it presupposes acts of deglutition during efforts to breathe. It must, however, be admitted to be possible, though very unlikely, that the water might have been swallowed a very short time before submersion.

The quantity of water is very variable; and depends partly on the number of respiratory efforts made during the act of drowning, and partly on the depth of the water. In animals stunned before immersion, as well as in those prevented from rising to the surface, the stomach contains no water; while in animals free to move it is found to be in proportion to the number of times they rise.

That the depth of water also influences the quantity found in the stomach is proved by the experiments of Dr. Taylor. The stomach of a cat held two feet below the surface of the Thames contained scarcely any water; but that of a cat lowered to the depth of fifty-five feet held a large quantity. The stomach of a third cat allowed to rise repeatedly to the surface, was distended, but not so much as the one that had been lowered to the depth of fifty-five feet. The columnar pressure of the water is, there-

fore, considerable; and it is probable, that where the water is very deep it may force the passage of the œsophagus, even though the animal died previously to submersion. But it has been shown by repeated experiments on animals that, as a rule, water does not enter the stomach after death. It appears, moreover, that water may enter the stomach when the tissues have been relaxed by putrefaction.*

It is obvious, then, that water in the stomach is not to be considered as conclusive evidence of death by drowning, when the water is of great depth, or when the body is far advanced in putrefaction. It must also be admitted to be possible that the water might have been swallowed immediately previously to immersion, and possible, also, though most improbable, that it might, as suggested by Orfila, be maliciously injected after death.

But though water in the stomach affords a presumption of death by drowning, its absence must not be taken as evidence to the contrary; for it is not present in death by drowning due to causes other than apnœa, such as shock, syncope, concussion, or apoplexy. The tendency to swallow may also be voluntarily resisted; or the body may be, in some way or other, prevented from rising to the surface.

On the other hand, water may have entered the stomach, and yet not be found there after death; for if the head be allowed to hang down, the water will escape. This fact also was proved by Dr. Taylor's experiments. Again, lengthened exposure after removal from the water, may cause the fluid in the stomach to transude through its coats, and disappear.

The absence of water from the stomach, therefore, is not conclusive against death by drowning, for it may have entered the stomach, and subsequently disappeared; or it may never have entered the stomach at all.

Froth, water, mud, or sand in the Air-Passages.—Mucous froth.—From experiments on animals made by Piorry and Orfila,

* The experiments of Liman (Casper's 'Handbuch,' vol. ii. p. 747, 5th edition), seem to throw considerable doubt on the value of the presence of water in the stomach as a sign of submersion during life. His experiments consisted in submerging the dead bodies of children in an artificial morass, compounded of water and easily recognisable material. The bodies were placed in this, some with the face upwards, some quite submerged, and then taken out after a day or two by the head or feet, or in no definite manner. In 16 experiments the material was found in the stomach seven times, and in the œsophagus, pharynx, and trachea fourteen times. Neither the degree of putrefaction, nor the length of time during which the bodies were allowed to lie in the morass, appeared to influence the result; nor did it matter whether the bodies were drawn out by the head or heels. He concludes from his experiments that the occurrence of water in the stomach or air-passages may be purely a post-mortem accident.

the presence of mucous froth in the air-passages was inferred to be due to the body rising repeatedly to the surface for air. In animals kept entirely under water no froth was found; and it was also absent when the body remained in the water a long time, or was subject to long exposure after its removal, as also when the head was placed downwards. But Casper, as the result of numerous observations, declares that these experiments do not admit of application to the human subject. He found froth in the trachea equally in those who could, and those who could not, have risen to the surface.—(Handbook, vol. ii. p. 238.) The value of this mucous froth as evidence of death by drowning is also impaired by the fact that it exists not only in the several forms of death by apnœa, but in death by apoplexy or epilepsy, and in catarrhal and other affections of the lungs.

Water in the Lungs.—That water generally enters the lungs in death by drowning has been abundantly proved by experiments on animals, and by cases in the human subject in which not only water but sand and mud, and leaves of plants, have entered the air-passages. By drowning rats in chalk and water, with free access to the air, I have never failed to obtain effervescence by means of acids in every part of the lungs. (G.)

But the value of this sign is impaired by the fact that water may enter the lungs of those who have been thrown in after death. Orfila and Piorry found, that the quantity which thus gained admission to the lungs, varied according to the position of the body, being large when it remained upright: less when horizontal.

The suggestion that water may be *injected* after death may be treated as a fanciful refinement. But water is not always present in the lungs in death by drowning; for, as in the case of the stomach, if the head is placed downwards, the water flows out. Long exposure, too, will cause it to transude and be lost.

Froth at the Mouth and Nostrils.—This, too, is a sign of death by drowning; but open to all the objections just stated in respect of froth in the air-passages. It has, indeed, a close dependence on the existence of froth in the air-passages, aided by the development of the gases of putrefaction forcing it into the fauces. Hence it is more common in summer than in winter.

Cutis anserina.—In death from drowning, whether in summer or winter, the body exhibits the appearance known as "goose-skin" or cutis anserina. This is caused by the contracted state of the *arrectores pili*, and is chiefly seen on the anterior surface of the extremities. The cutis anserina may, however, be found in death from other causes, and particularly in cases of sudden death

with nervous excitement. Taken by itself, its presence does not prove death by drowning, but its absence would be a serious objection to the fact of death by drowning unless other signs were of an unusually pronounced character.

Retraction of the Penis.—Casper alleges that, in men who have fallen into the water alive, and died by drowning, he has almost never failed to find this appearance, while he has not observed it so constantly after any other kind of death.—(Handbook, vol. ii. p. 236.)

From this examination of the signs of death by drowning, it appears that there is no single one on which entire reliance can be placed. But when several signs coincide, the probability is greatly strengthened. Like the symptoms of disease, they may be of little value when taken separately, but when combined they enable us to form a safe diagnosis. Some authors, and Orfila among the number, have, indeed, thought that the question, Was death due to drowning? admits of no decision; but from this opinion Devergie and Casper very properly dissent.

It should also be borne in mind, that the most characteristic appearances of death by drowning are not permanent. In winter they may continue after the body has lain from fifteen to eighteen days in the water, but in summer they may disappear as early as the third day. Exposure to the air also causes them rapidly to disappear, and in the height of summer a few hours may suffice to dissipate them. Advanced putrefaction dissipates all the signs of death by drowning.

The time that the body has remained in the water will be determined approximately by the signs laid down at p. 254.

The evidence derived from the signs of death by drowning ...uits of being confirmed or invalidated by the condition of the ...y in other respects, especially by the presence or absence of

...Marks of Violence.—With regard to injuries on the bodies ...rsons found in the water, three questions arise:—

Were they inflicted during life? 2. If so, are they such ...o account for death before submersion? 3. Were they ...ental, suicidal, or homicidal?

...e first and third questions are fully discussed under the ...of wounds. The immersion of the body in water will in... the decision of these questions, only in so far as the ...s are thereby altered in appearance.

...the Injuries such as to account for Death before Sub...?

...s are five ways in which a body taken from the water ...ne *to exhibit marks* of violence. 1. A man may be

murdered, and thrown into the water dead; 2. He may receive severe injury from the hands of others or himself, and may then be thrown (or throw himself) into the water while still alive. If the injuries are in the shape of bruises, they may have been caused 3. By the death struggles; 4. By some obstacle against which the body is borne; 5. In the very act of falling into the water.

1. In a man who has been murdered and thrown into the water dead, we should expect to find all the signs of death by drowning absent, with the exception of such as may have been caused by uncommon depth of water, or advanced putrefaction.

2. On the supposition that a man found in the water had first been severely injured and then thrown in alive, we might expect to find signs of drowning proportioned in number and distinctness to the strength still left after the violence inflicted.

3. The bruises caused by the struggles of the drowning man would not be so severe or extensive as to endanger life.

4. The bruises caused by fixed obstacles, against which the body might be borne by a running stream, would not be strongly marked. It is not likely that such severe injuries as dislocations or fractures could originate in this way, unless the obstacle were in motion—*e.g.* a water-wheel.

5. *Falling into the Water.*—A person who falls or throws himself from a height upon a hard bank or pier of a bridge, may not only be severely bruised, but sustain such severe injuries as fractures of the skull or limbs, and severe lacerated wounds.

Dislocation of the limbs is a possible consequence of falling from a great height. Many years since, as stated by Dr. Gordon Smith, a man who used to jump from the parapet of London Bridge into the Thames for a wager, and had previously performed the feat with impunity, sank and was drowned. Both arms were found dislocated, in consequence, it is thought, of his having fallen with them stretched out instead of close to his sides, as was his wont.

Two cases are also recorded (South's edition of Chelius's Surgery, vol. i. p. 532), the one of fracture of the body and arch of the fourth cervical vertebra, the other of fracture of the body of the fifth vertebra, caused by jumping into the water. The deaths were attributed to a sudden retraction of the head to avert collision with the bottom.

The medical man should, therefore, ascertain whether the drowned man fell from a height; whether the water is a rapid stream; and whether the body was found near obstacles fixed or in motion; and if there are no such causes as these to account for the injuries sustained, he may fairly trace them to some

cause preceding the immersion. In bodies found in shallow still water, marks of violence afford strong presumption of homicide.

Assuming death to have been due to drowning, another question arises—

Was the Drowning the result of Accident, Suicide, or Homicide?—This question is exceedingly difficult to answer; for if there are no marks of violence on the body, it is not possible to say whether the man fell in, or jumped in, or was pushed in; and in respect of bodies found in running streams, it may not be possible to ascertain at what point they entered the water.

Nor if we find the hands of the drowned man grasping leaves or grass, showing that he had struggled hard while in the water, can we affirm that he was thrown or pushed in by others.

Nor again, does the fact of a man being drowned in a shallow stream of water exclude the idea of homicide; for if a strong man were to hold the head of a weak or infirm one in a basin of water, he might drown him just as effectually as in a deep stream. On the other hand, it should be borne in mind that cases of suicidal drowning in shallow water, or in very narrow spaces, such as small house-cisterns, do occasionally occur.

It is evident, from what has been stated, that where there are no marks of violence on the body, we have no means of determining whether the drowning was the result of accident, suicide, or homicide; and that external injuries, to throw any light upon the question, must be such as could not have been inflicted by the drowned man himself prior to immersion, or by the accidental striking of the body against an obstacle in entering the water, or during the death struggle.

There is one case which would at first sight seem conclusive of homicide, namely, where a body is found in the water tied hand and foot. Dr. Smith, however, relates the following case:—In July, 1816, the body of a gauging-instrument maker, who had been missing for some days, was discovered floating down the Thames. On being taken out, his wrists were found tied together and made fast to his knees, which were in like manner secured to each other. He had been deranged for two years. The cord with which he had tied himself was recognised as the one with which he used to raise himself in bed. He was a good swimmer, and probably took the precaution of disabling himself. The verdict was "Found drowned." Two similar cases are on record, one by Foderé, in which the hands and fingers were tied together with a silk riband in numerous folds; and another in the ninth volume of the 'Annales d'Hygiène,' in which the feet, wrists, and neck were tied. Foderé in the one case, and the medical ex-

aminers (*Marc, Guichard, &c.*) in the other, gave their opinion in favour of suicide. In such cases as these it would be necessary to determine whether the knots or folds admitted of being made with the teeth, or by any movements of the hands or limbs.

Treatment of the Drowned.—Before describing the proper treatment of the drowned, it may be well to recall the fact that in most deaths by drowning the cause of death is apnœa, simple or mixed; and that the means to be adopted are those which would be prescribed in other cases of suffocation, with certain obvious modifications suggested by the death having occurred in the water. The contact of the water, for instance, lowers the temperature of the skin, and renders necessary more prompt and sustained attempts to restore it. The lungs and stomach should also be relieved of the water which had entered them.

The following rules for the treatment of the drowned are in accordance with the method of Dr. Henry Silvester, which has now, by general consent, taken the place of that recommended by Dr. Marshal Hall. Send immediately for blankets and dry clothing, but treat the patient instantly on the spot, in the open air. First place the body, for a few seconds, with the face downwards, the head lower than the feet, the mouth open, and the tongue drawn forward; then turn the body on the back, place it on an inclined surface, raise the shoulders and support them, and fix the feet. Now grasp the arms at the elbows, draw them above the head, and keep them on the stretch for two seconds, then reverse the movement for the same length of time, pressing the arms firmly against the sides of the chest. Repeat this twofold movement fifteen times in the minute, till a spontaneous effort at respiration occurs. Then remit the movements, and proceed to promote the circulation and restore warmth by firm friction and pressure directed upwards, by hot flannels, hot bottles, bladders of hot water, or heated bricks; or borrow warm clothing from the bystanders. Respiration may be promoted by smelling salts, tickling the throat with a feather, and by the alternate dash of cold and warm water on the face and chest. When the respiration is restored, warm brandy and water, wine and water, tea or coffee, may be given; and the patient being put to bed, should be allowed to sleep. Our efforts to restore life should be persevered in for three or four hours, or till some certain sign of death has shown itself.

DEATH BY HANGING.

In the five years 1852-56, 494 persons perished by hanging, in England and Wales, of whom 384 were males and 110 females.

Of the 494 deaths, 451 were ascertained suicidal acts, 394 by men and 102 by women. Judicial executions account for 7 of the deaths. In the whole five years only one death (of a child under five years old) was set down as an act of homicide. In 1871, 448 males and 100 females committed suicide by hanging.

As the cause of death is the same in hanging, strangulation, and suffocation, it may be well to make a few preliminary observations on these modes of death before proceeding to examine them separately.

Though in common language, death from any of these three causes is due to *suffocation*, this term has in medico-legal language a distinct meaning of its own. It means death caused by some impediment to the respiration, which does not act by compressing the larynx or trachea. Thus a man is said to be suffocated if his mouth and nostrils are closed, or if he is prevented from breathing by pressure on the chest or abdomen. Certain noxious gases, too, are said to destroy life by suffocation. The subject of suffocation, then, separates itself at once from those forms of death (hanging, strangulation, and throttling) in all of which pressure is exercised on the *air-tube* and *throat*.

The most simple cause of death is *throttling*, or direct pressure on the trachea with the fingers. Here the cause is obvious; it is the same as in many cases of drowning; the same as in suffocation—viz., *apnœa* (*asphyxia*). Death takes place from the mechanical hindrance to respiration. But the cause of death is not so clear when the entire circumference of the neck is subject to pressure; for in this case not only the larynx or trachea, but the blood-vessels also suffer. In some instances both air-tubes and blood-vessels are implicated; in others the air-tubes suffer compression and the vessels escape; in others, again, the air-tubes escape and the vessels sustain all the pressure. The respiration and circulation are most completely impeded when a cord is fixed round the lower part of the neck, so as to embrace the trachea, and the large vessels at their entrance into and exit from the chest; or when it is applied, or drawn by the weight of the body, beneath the lower jaw. Both functions are less interfered with when the cord is fixed directly over the larynx, as the projections of the os hyoides and thyroid cartilage afford some protection to the windpipe and blood-vessels.

This variation in the position of the ligature, and in the pressure which it exercises on the organs of respiration and circulation respectively, explains the difference in the length of time required to destroy life in all those cases in which death does not take place instantaneously from injury to the spinal cord; and

the simultaneous compression of the air-tube and blood-vessels gives rise to the question, whether the pressure on the air-tube or on the blood-vessels is the immediate cause of death. In other words, is death caused by *apnœa*, or by *apoplexy*?

It was formerly the general belief that death was due to *apoplexy* and this opinion was not unreasonable, for it is well known that mere pressure with the fingers on the carotid artery will cause sleep, by checking the supply of blood to the brain, and that apoplexy is often brought on, in persons predisposed to that disease, by the pressure of a cravat impeding the return of blood through the veins. That apoplexy, therefore, may be brought about by pressure on the large blood-vessels is not to be doubted, but the question still recurs—in those cases of suspension or strangulation in which the air-tube and blood-vessels are simultaneously compressed, to which of the two pressures is death to be attributed? Both causes doubtless contribute to the fatal result, but the stoppage of the respiration is certainly the essential cause; for death by apnœa would be much more speedily and certainly induced by a complete or partial stoppage of the breathing, than fatal apoplexy by the complete or partial arrest of the circulation. But an appeal may be made to actual experiment for the decision of this question. A dog was suspended by the neck with a cord, an opening having been previously made in the trachea below the place where the cord was applied. After hanging for about three-quarters of an hour, during which time the circulation and breathing went on as usual, the animal was cut down, and did not appear to have suffered materially. The cord was then shifted below the opening into the trachea, so as to stop the ingress of air into the lungs; and the animal being again suspended, was in a few minutes quite dead.* In this experiment the compression of the vessels was probably less than it would be in many cases of death from hanging in the human subject, in which the violence employed, the height of the fall, and the weight of the body combine to tighten the cord, and thus exercise the strongest pressure on the vessels as well as on the air-tube.

A similar operation on the human subject is described by Smith.†

"A man of the name of Gordon was executed at Tyburn, in April, 1733. Mr. Chovet having by frequent experiments on dogs, discovered that opening the windpipe would prevent the fatal consequences of the halter, undertook to save Gordon, and

* 'Cyclopædia of Practical Medicine,' Asphyxia.
† 'Forensic Medicine,' Appendix, p. 561.

accordingly made an incision in his windpipe, the effect of which was, that when Gordon stopped his mouth, nostrils, and ears for some time, air enough came through the opening to allow of the continuance of life. When hanged, he was observed to be alive after all the rest were dead; and when he had hung three-quarters of an hour, being carried to a house in the Tyburn road, he opened his mouth several times and groaned; and a vein being opened he bled freely." But these were the only signs of life. Dr. Smith attributed the want of success to the great weight of the man, coupled perhaps with the insufficiency of the opening into the trachea. It is obvious that the same results would happen if an equal pressure by strangulation were substituted for the weight of the body.

It appears, then, that when the windpipe and the large blood-vessels suffer compression, death may be attributed to apnœa; that when the respiration is free, or but slightly affected, pressure on the vessels may cause death by apoplexy, but more slowly; and that when respiration and circulation are both impeded, both may contribute to the fatal result, though the hindrance to the respiration is the more efficient.

It has been suggested that the immediate cause of death in hanging and strangulation is pressure on the nerves which subserve the function of respiration; but as such pressure does not prove fatal till the lapse of many hours, this explanation must be rejected.

Having now examined the questions common to death by hanging and by strangulation, the subject of death by hanging may be resumed.

Death takes place very suddenly in certain cases of suspension, either from fear producing syncope as in some cases of drowning, or from injury to the spinal cord by luxation of the cervical vertebræ, fracture of the odontoid process, or rupture of the intervertebral substance. These injuries to the spine being caused either by the fall of the body from a height, or by a rotatory motion given to the body at the moment of the fall.

Death by hanging takes place, then, in different ways and at different intervals of time. The more speedy deaths may be traced to injury of the spinal marrow above the origin of the nerves of respiration, and, more rarely, to syncope from fright. Next in point of rapidity will be death from *apnœa*, and the least rapid that by apoplexy.

We are not without information as to the sensations that accompany death by hanging. Suicides saved from death, and philosophers who have instituted experiments on themselves, have

both contributed something to our knowledge. It appears that these sensations are not always the same; and the difference probably depends on the various degrees in which the windpipe and blood-vessels are compressed. Some have retained no recollection of what happened to them; others were conscious of sudden loss of sense and motion; in others a deep sleep was ushered in by flashes of light, by a bluish flame, by brilliant circles of colours, or by more definite ocular illusions, accompanied by hissing or singing in the ears. In other instances the sensations are stated to have been extremely pleasurable, though of short duration. These sensations resemble those that occur in cases of disordered cerebral circulation, and those that usher in the fits in some cases of epilepsy.

But it is only in cases of suicide that these pleasurable sensations manifest themselves. In homicidal cases, when much violence is used, the countenance expresses suffering; the eyes are brilliant and staring, and seem to be bursting from their sockets; and the eyelids open and injected; the tongue, swollen and livid, is forced against the teeth, or more or less protruded from the mouth, and compressed or torn by the contracted jaws; the lips are swollen and the mouth distorted; and blood, or a bloody froth, hangs about the mouth and nostrils; the arms are stiff, the hands livid, and the fingers so forcibly closed on the palm as to force the nails into the flesh; and the convulsions are so violent as even to cause the expulsion of the contents of the bowels, and to produce erection of the penis, with expulsion of the urine, semen, or prostatic fluid. The circumscribed rose or violet discolorations on the trunk and extremities common to all cases of death by apnœa are strongly developed; the course of the cord is distinctly indicated by a well marked bruise, or by some of the appearances presently to be described; and, on dissection, the muscles and ligaments of the windpipe are found stretched, bruised, or torn, and the inner coats of the carotid arteries sometimes divided.

The internal appearances are those of well-marked apnœa. The lungs are sometimes distended with air, sometimes collapsed.

Two principal medico-legal questions arise in regard to persons found hanged. 1. Did the suspension take place during life, or after death? and, 2. Was the hanging accidental, suicidal, or homicidal?

1. *Did the suspension take place during life, or after death?*

The points most worthy of attention as bearing on the solution of this question are:—*The mark of the cord; The appearance of the countenance; The position and state of the tongue; The*

condition of the genital organs; and *The expulsion of the fæces.*

The Mark of the Cord.—The appearances on the neck due to suspension during life are by no means uniform. The homicidal cases involving strong struggles, the neck sustains great injury, marked by the bruised skin, and the torn state of the subjacent parts; but in judicial and suicidal hanging much less injury is done both to the surface and to the deeper-seated parts.

In those cases (both judicial and suicidal), in which the position of the cord is mainly determined by the weight of the body, it follows pretty closely the line of the jaw-bone, and there is an oblique indented mark, of the colour of a recent bruise, on the fore part of the neck, and yellowish brown, as if from a singe, towards the angle of the jaw. The bruise may correspond with the whole breadth of the ligature; or there may be a deep groove, bordered by two discoloured lines. The mark varies with the size and texture of the cord, being less distinct when a soft material, such as a handkerchief, is used, than when a hard ligature, such as a rope, is employed. When the material is hard and resisting, the number of times that the ligature has been passed round the neck, and the material of which it consists, are clearly displayed. But in many cases of judicial and suicidal hanging, the mark of the rope consists at first of a simple depression without any change of colour, oblique if due to the weight of the body, horizontal if firmly fixed round the neck. After the lapse of several hours, the rope-mark assumes a light-brownish tint, and if an incision be made into the skin the cellular membrane is found strongly compressed, so as to form a shining white band. Sometimes the pressure is not equal on the two sides, or the back of the neck escapes. Sometimes, also, the pressure is lessened by the beard. The countenance, as will be presently more fully stated, is at first pale and its expression natural, and it is not till several hours have elapsed, that it assumes a livid tint, and still longer before it wears a bloated appearance.

In a case of judicial hanging, in which the cord was removed soon after the body had been cut down, we observed merely a depressed circle on the fore part of the neck, and a slight excoriation, with a burnt appearance over the angle of the jaw. In a case of suicidal hanging with a small rope tied firmly round the neck, which was removed without delay, there was a white depressed line deeper at the back of the neck than in front, and assuming a dusky hue after the lapse of several hours. The strands of the rope were distinctly marked, but there was no ecchymosis on any part of the neck. In another case of suicidal

hanging a hard depressed chocolate-coloured band completely surrounded the neck, and corresponded to the rope of coir which had been used.

The appearances, then, produced by the cord in cases of hanging during life are not always the same: in some cases there is a well-marked bruise or ecchymosis, in others an indentation without discoloration, and a condensed state of the subcutaneous tissues, resembling old parchment; in others, again, a hard depressed chocolate-coloured line; and these marks limited to the fore part of the neck, may be combined at the angle of the jaw with a singed appearance. The cuticle may also be abraded here and there.

The question, whether *the appearances occasioned by the cord during life can be produced after death?* has been answered in the affirmative. In the Chapter on Wounds and Mechanical Injuries, it will be shown that bruises may be produced for some time after life is extinct; and that which is true of bruises in general will of course hold good with respect to this particular form of bruise. Accordingly Orfila proved, by experiments on the dead body, that, up to eighteen hours after death, precisely the

Fig. 31.

same appearances may be produced as in suspension during life; Devergie has produced the parchment-like condition of the skin and subjacent cellular tissue, as well as the ecchymosed appearance bounding the depression; and Casper sums up the results of a long series of experiments by the remarkable statement "that any ligature with which any body may be suspended or strangled, not only within a few hours, but even days after death, especially

be forcibly pulled downwards, may produce a mark
ilar to that which is observed in most of those hanged
;" and he adds that he has been convinced by his
that *the mark of the cord is a purely cadaveric*
. (Handbook, vol. ii. p. 173.)

these confident statements of Casper, based upon
riments and large experience, I should have attached
to the dark depressed chocolate-coloured line which
red in one case of suicide, accompanied by so con-
ndition of skin that, when cut, it resembled closely the
rawn. The appearance of the neck is well shown in
ing (fig. 31) taken from a photograph, which also
results of an experiment made with the same cord
ed in the suspension. This was fastened tightly round

Fig. 32.

within an hour of the death and
out 20 hours. The result was
depressed mark of the size of
howing the projecting strands in
ssions, the rest in faint rose-
ness. This mark did not deepen
by exposure. The only other
worthy of note was the deep
colour of the ears.

ide had attached a neckerchief to
nd through the loop he had
mall rope of coir, by which he
himself. He had climbed on to
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arly touched the floor of the cell.
(G.)

n in those cases in which the
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, indeed, any evidence of great
would furnish a strong probability
ion during life, or of suspension
ble strangulation.

of the Countenance.—In death by hanging, whether
r suicidal, the countenance is usually pale, and the ex-

pression natural. But this pallor of the face is followed, after a few hours, by a livid hue of the lips, eyelids, ears, and face generally; and, after a still longer interval, by a marked congestion of the countenance. There is nothing in the expression or colour of the face to show that suspension took place during life or after death; but if the vessels of the head and face are found highly congested in a body recently cut down, there is a probability of suspension during life; for suspension after death, though it might produce discoloration of the neck, could not cause turgescence of the vessels of the head and face.

Position and State of the Tongue.—The same injected and swollen state of the base of the tongue, with or without protrusion, which occurs in other forms of death by apnœa, occurs also in death by hanging, and affords a strong probability of suspension during life.

State of the Genital Organs.—The genital organs of both sexes are affected in death by hanging. In the female, redness of the labia and discharge of blood have been occasionally noted, and in the male a more or less complete state of erection of the penis with discharge of urine, of mucus, or of the prostatic fluid, is present in at least one case in three. There may also be discharge from the urethra without erection. But it must be borne in mind, that these appearances in the genital organs, when they do occur, are not characteristic of death by hanging or strangulation, for they have been observed in other forms of violent and sudden death, as in fatal gun-shot wounds of the brain, and of the large vessels, and in poisoning by prussic acid.

This sign then, when present, is of considerable importance, for it is strictly vital, and affords a sure proof of violent and sudden death; and if combined with characteristic external signs and internal appearances, of death by hanging. On the other hand, the absence of erection and emission is no evidence that death was not due to this cause.

Expulsion of the Fæces.—This happens in about one-fourth of the cases of death by hanging; but as it also occurs in other forms of sudden or violent death, it needs to be confirmed by characteristic appearances, external and internal.

2. *Accident, Suicide, or Homicide.*—Accidental hanging is very rare. One case is given by Gordon Smith:—It was that of a girl who was swinging in a brewhouse, and near the rope used by her for that purpose was another for drawing up slaughtered sheep. In the course of the exercise her head got through a noose of this second rope, by which she was pulled out of the swing, and kept suspended at a considerable height, until she died. Dr. Taylor also

relates a case communicated to him by one of his pupils:—A boy ten years old had been amusing himself by fastening a piece of plaid gown to a loop in a cord suspended from a beam in the room. In the act of swinging he raised and turned himself, when the loop of rope suddenly caught him under the chin, and suspended him until life was extinct. A playmate witnessed the occurrence.

With the exception of a few cases of this class, in which the mode of death is obvious, the question under consideration is narrowed to this: *Was the hanging suicidal or homicidal?* The figures of the Registrar-General show that the probability is always strongly in favour of suicide; and, for obvious reasons, hanging is a mode of death which a murderer is not likely to select. It presupposes a great disproportion of strength between the murderer and his victim, or a combination of two or more persons against one. The solitary ascertained case of homicide in the five years 1852 to 1856, was committed on a young child.

There would be nothing in the appearance of the body itself, beyond the marks of a severe struggle, to distinguish the homicidal from the suicidal act; but if a man were found suspended at a height from the ground which he could not by any possibility have reached, and with no object near on which he could have mounted, we must conclude that he was suspended by another.

It was once supposed that a man found with the feet or some part of the body touching the ground was more likely to have been hanged by another than by himself; but careful observation has shown this to be an error, for suicides have been found, not only with the feet touching the ground, but with the knees bent and raised from the ground, or in such postures that death must have been produced by leaning forcibly forward so as to compress the windpipe.*

As in most of the cases in which the body touches the ground the cord would not be so put on the stretch as to give it its usual oblique position, there would be no difference between such cases and cases of strangulation, except, perhaps, that in the latter the mark would be more distinct, and would embrace a greater portion of the neck.

The marks of violent struggles on the clothes or person of the deceased, or of severe injuries, would justify a suspicion of homicide; but as severe and extensive injuries have been known to be

* A great many cases, in which the bodies of suicides were found placed in every possible attitude, are given, illustrated by engravings, in an interesting paper in the fifth volume of the 'Annales d'Hygiène.'

produced by a suicide, and slighter injuries may take place accidentally, this criterion must be used with caution.

It may be well to add that persons found suspended have been previously killed by strangulation or by other violence, or by poison.

DEATH BY STRANGULATION.

This mode of death is rare compared with death by hanging. It accounts for 50 deaths in the year, of which 37 in males and 13 in females. Only half of these deaths were ascertained to be suicidal; of which 20 in males and 5 in females. Homicide by strangulation, though much more common than by suspension, is rare in adults, but common in children.

Death by strangulation differs from death by hanging only in the fact that the body is not suspended; but some of the cases of suicidal hanging in which the body touches the ground might with equal propriety be set down to strangulation.

Strangulation is usually effected by the uniform pressure of a ligature round the neck; but in rare instances some hard substance is introduced into the folds of the ligature, and placed over the windpipe.

From this distinction between death by hanging and death by strangulation, it follows that, as a rule, the mark on the neck will differ in the two cases, being oblique and high in the neck in death by hanging, circular and low down in death by strangulation. From this general rule, however, those cases of hanging must be excepted in which the cord is firmly fixed, and those in which the body touches the ground; and those rare cases of strangulation in which the ligature happens to be fixed somewhat obliquely. The mark in hanging, therefore, may happen to be circular, and that in strangulation more or less oblique. The introduction of a foreign body into the folds of the ligature would be indicated by the greater size and distinctness of the bruise over the windpipe.

Another difference between strangulation and hanging is, that in strangulation much more force is used; hence the mark on the neck will be more distinct, and the injury to the subjacent parts greater; and this will be especially the case in homicidal strangulation, for the murderer generally uses unnecessary violence.

The same questions arise in respect of strangulation, as of hanging—viz., 1. *Was death caused by strangulation?* 2. *Was the strangulation accidental, suicidal, or homicidal?*

1. *Was death caused by Strangulation?*—A cord applied a few hours after death would not produce that amount of bruise which

would result from its application during life; and the turgescence of the countenance, as well as the characteristic post-mortem appearances, would be wanting. It is only, therefore, in suicides, and in the scarcely conceivable case of slight force being used by the murderer, or death taking place suddenly, from shock or syncope, that the appearances produced by a cord applied during life could resemble those due to its application after death. The same observations apply to direct pressure on the windpipe. As, moreover, hanging is known to be the more common suicidal act, the murderer is not likely to hide the real mode of death by simulated strangulation. It is much more probable that having strangled his victim, he would try to conceal the real mode of death, by suspending the body or placing it in a position suggestive of suicide.

In the well-known case of Bartholomew Pourpre, the deceased was first strangled and then suspended, and the mark of the cord was found at the lower part of the neck, while the teeth knocked in, and the bloody mouth, showed the violence that had been used.

The murderers of Sir Edmondbury Godfrey, after strangling him near Somerset House with a twisted handkerchief applied with great force, concealed the body for a time, and then carried it to Islington, threw it into a ditch, passed his own sword through him, and laid his gloves and other articles of dress on the bank, so as to create the belief that he had committed suicide. The absence of blood from the wound, though the sword had passed through the heart, excited suspicion, which was fully confirmed by the discovery of a bruise, an inch broad, extending round the neck, and a fracture of the cervical vertebræ, which rendered the neck so flexible that it could be turned from one shoulder to the other. The face, which during life was remarkably pale, was livid and suffused, and the eyes bloodshot.

2. *Accident, Suicide, or Homicide.*—That strangulation, like hanging, may be accidental, is proved by the following cases:—

An ingenious young man, having nearly lost the use of his arms, was in the habit of moving a heavy weight by a cord attached to it and passed round his neck. One morning, soon after having retired to his room, his sister found him sitting in a chair quite dead, with the cord twisted round his neck. The deceased must have attempted to move the weight in the usual way, but it had slipped behind, and so strangled him. (Smith.)

In July, 1839, Elizabeth Kenchan, an extremely dissipated, drunken, and disorderly woman, went to bed intoxicated, with her bonnet on, and in the morning was found strangled in its strings. She had fallen out of bed, her bonnet became fixed

between the bedstead and the wall, and she, being too drunk to loosen the strings, was strangled.

In a few cases, then, death by strangulation has been due to accident; but if we have convinced ourselves that death did not take place in this way, the question is narrowed to the alternative of -

Suicide, or Homicide.—Strangulation appears to be a suicidal act in about half the recorded cases. As it is difficult for a man to strangle himself by the pressure of his hands even with the aid of a ligature, some mechanical contrivance is usually resorted to. In one case (Orfila), two cravats were twisted several times round the neck; in another (Dunlop), a Malay used a small stick for the same purpose; in a third case, the handle of a pot was used. In the year 1838 a Mr. Watson, aged 88, strangled himself by placing a poker through the tie of his neckerchief and twisting it round and round.

Strangulation by pressure of the hand on the trachea (throttling) may be safely assumed to be homicidal, as in the following case. A robust man, on some slight provocation, seized another by the cravat, and pressed him firmly against a wall till he was dead. On examining the body, the face was found livid and swollen, and the features distorted; and there was considerable discoloration and depression where the pressure had been applied. There were witnesses to the act, and the man was proved to be insane. (Case at the Chester Assizes, April, 1835.)

An unsuccessful attempt to attribute death to accidental throttling was made in 1763, in the well-known case of Beddingfield.

He was found dead in his bed-room, and his wife and manservant were charged with the murder. The medical testimony was very unsatisfactory, as no dissection had taken place, but it was proved that there were marks on the neck resembling those of fingers. One surgeon said there were marks of a thumb and *three* fingers; the other of a thumb and *four fingers*; while another witness saw only *two*, "which looked as if the blood was set in the skin." The deceased was found lying on his face on the floor, with one hand round his neck. One of the criminals after condemnation confessed that he had strangled Beddingfield in his sleep by seizing his throat with his left hand; and that though he struggled violently and made some noise, he soon accomplished his purpose.

The appearances caused by throttling, when great resistance is offered, may be inferred from the evidence of Mr. W. Wilson in the case of Hector M'Donald, convicted of the murder of his wife, at Inverary, April, 1857. There was an abrasion on each

side of the windpipe, five abrasions on the left, and three on the right arm; and the skin on the front and sides of the neck, and on the upper part of the chest was blackened. On the throat were the marks of a thumb and three fingers. It was inferred that the throat had been grasped by the left hand, of which the wrist was pressed upon the chest, and that the right hand had grasped the left arm of the victim. The internal appearances were highly characteristic of death by apnœa. The substance and membranes of the brain were injected; the lungs and right side of the heart contained a quantity of dark fluid blood; the left was nearly empty. All the internal viscera were healthy.

The following is a case of homicidal strangulation by a foreign body introduced into the ligature;—Dr. Clench, a London physician, was called out of bed by two men on the night of the 4th of January, 1692, to visit a sick friend. He entered a hackney coach with them, and was driven about several streets in the City for an hour and a quarter. The men then left the coach, and sent the driver on an errand. When he returned, he found Dr. Clench sitting on the bottom of the coach, with his head on the cushion of the front seat. Thinking him in liquor, he shook him, but obtained no answer. He then called the watch, and they found him strangled by a coal wrapped in a handkerchief, and applied directly over the windpipe. The coachman had heard no noise while driving the carriage.

DEATH BY SUFFOCATION.

Under this head are comprised all cases of apnœa, not produced by direct pressure on the windpipe, with the exception of drowning, which has already been treated separately.

On an average of the five years 1852 to 1856, 708 deaths by suffocation occurred, of which 427 in males, and 281 in females. Of the whole number, 106 were infants killed by overlying, and about 180, also infants, were suffocated by bed-clothes; 57, of whom the majority were young children, were suffocated by their food, 38 by gases, chiefly carbonic acid. Two suicides, five murders, and one manslaughter by suffocation are reported to have happened annually. In 1871, among deaths by accident or negligence, 876 in males, and 628 in females, are attributed to suffocation.

Suffocation may take place in many ways.

1. *The mouth and nostrils may be stopped* accidentally or by force. A person in a state of helplessness, from whatever cause,

may fall on the face and be suffocated by water or loose earth; and new-born children by the discharges, by the bed-clothes, or by being overlaid in bed. Murderers have also despatched their victims by this means.

2. *Mechanical Pressure on the Chest.*—This may occur from accident, as when a quantity of earth or rubbish falls upon a man; or as a homicidal act, combined with strangulation, the murderer pressing with his whole weight on the body, and compressing the windpipe with the hand; or compressing the chest and closing the mouth and nostrils. Suffocation by pressure on the chest constituted part of the *peine forte et dure* of our ancient law. A risk of accidental suffocation by pressure on the chest has been incurred in taking casts with plaster of Paris.

On the 14th of June, 1837, no less than twenty-three persons lost their lives at the Champs de Mars by pressure in a crowd, death being due partly to suffocation and partly to severe injury to the chest.

3. *Closure of the Glottis.*—This also may occur accidentally, as in the 57 cases mentioned above of suffocation by food. When this happens in adults they are usually intoxicated, or in a fit. Thus Paris and Fonblanque quote the case of a patient who died in an epileptic fit after a heavy meal of pork. The trachea contained a quantity of matter, resembling the pork on which he had recently dined. Suffocation by food is not an uncommon termination of the general paralysis of the insane.

Among familiar examples of accidental suffocation may be cited the death of Anacreon, attributed to a grape-seed; and of Gilbert the poet to a piece of mutton. There is a case on record of suffocation from swallowing a bee in some honey; and another from slaked lime getting into the larynx. Such small bodies as a piece of potato-peel have been found impacted in the rima glottidis, and small morbid growths, and the products of inflammation have often sufficed to close this narrow passage.

Suffocation has also been often threatened and sometimes brought about by bodies impacted in the upper part of the gullet. Slaves, both in ancient and modern times, are alleged to have swallowed their tongues. Some article of dress, such as a handkerchief, has been swallowed, and one determined suicide caused a fatal hæmorrhage by swallowing a cork bristling with sharp pins. The preparation is in the museum of King's College.

Suicidal suffocation by the vapours of charcoal are not common in England but very frequent in France.

Suffocation is not a mode of death often resorted to by mur-

derers, in the case, at least, of young and vigorous adults; for the force required is such as to reveal the cause of death by external marks and internal appearances; but when the body is very weak from any cause, as in the new-born infant, the old man, or the intoxicated, suffocation is not very difficult to effect, and if not attended by great violence, might not betray itself by the state of the body externally or internally.

The post-mortem appearances present in well-marked cases of death by suffocation may be inferred from Dr. Ollivier's account of the persons suffocated in the Champs de Mars. In the twenty-three persons, without exception, the skin of the face and neck was of a uniform violet tint, spotted with blackish ecchymoses. In nine, the eyes were bloodshot; in four, a bloody froth ran from the mouth and nostrils; in four, blood flowed from the nostrils, in three, from the ears; seven had fractures of the ribs; and two, females, fracture of the sternum. In sixteen bodies that were opened, the blood was black and fluid, and filled all the large veins at the right side of the heart. The pulmonary tissue was mostly of a reddish-brown, and in three quarters of each lung, posteriorly, there was a considerable accumulation of black and liquid blood; but there was no ecchymosis, either on the surface or in the substance of the lungs, except in one case. In all the cases in which the eyes were bloodshot, and in those in which blood flowed from the ears, the vessels of the pia mater and substance of the brain were gorged.

State of the Lungs.—Two appearances frequently occur in death by suffocation, viz., partial emphysema, and punctiform ecchymosis.

The surface of the lungs in most cases of death by suffocation, instead of being smooth, has an uneven or tuberculated character, due to the occurrence of partial vesicular or interstitial emphysema. A section into one of these patches shows that the parenchyma of the lung is affected.

The punctiform ecchymoses (Tardieu's spots) are found most commonly in children who have died of suffocation, but they may also occur in adults. They are minute spots on the pleura (visceral and costal), but are not confined to the surface of the lungs, for they may be observed on the aorta, the heart, or the diaphragm, and also on the surface of the abdominal viscera, as well as on the inner surface of the scalp. The surface of the lung looks as if it had been sprinkled with drops of a dark purple fluid. They are due to rupture of capillaries from over-distension, and occur, according to Lükomsky, when efforts at expiration continue, thus

enormously raising the general blood-pressure. Tardieu thought that they were diagnostic of death by suffocation as distinguished from other modes of death by apnœa. This opinion, however, is not confirmed by other observers, for they may occur where a similar condition as regards the relation between the respiratory movements and the blood-pressure exist. They occur in children from interruption of the placental circulation. These spots indicate death by asphyxia in some form, but not the mode in which it was brought about. They are commonly met with in the lungs of new-born infants. (See p. 91.)

From the slight injuries caused by the suffocation of helpless people, this mode of death was, previous to the passing of the Anatomy Act, selected by the murderers Burke and Bishop. Burke, with his female accomplice, Macdougall, was tried at Edinburgh in 1828, and Bishop, with Williams and May, in London, in 1831.

Burke killed Margery Campbell, by sitting on her body, covering her mouth and nostrils with one hand, and applying the other forcibly under the chin.

Fifty-nine hours after death, the eyes were closed; the features composed, as in deep sleep, red, and somewhat swollen; the lips of a dark colour; and the eyes bloodshot. There was a little fluid blood on the left cheek, apparently from the nostrils; the tongue was not protruded or torn by the teeth, but there was a slight laceration on the inside of the upper lip opposite the left eye-tooth; the cuticle under the chin was much ruffled, and the surface of the true skin, when laid bare, was dry and brown; but there was no bruise. The integuments, except on the face, were perfectly free from lividity. The joints were flaccid. There was no effusion of blood or laceration of the parts around the windpipe, and no injury of the cartilages, but the os hyoides and thyroid cartilage were further apart than usual, in consequence of the stretching of the connecting ligament. The following were the internal appearances: The membrane of the windpipe healthy, with here and there some tough mucus, not frothy, and a few points of blood between it and the membrane. The organs within the chest perfectly natural; the lungs remarkably so. The blood throughout the body was black and fluid, and accumulated in the large veins, and in the right cavities of the heart. The abdominal viscera, with the exception of incipient disease of the liver, were healthy. The brain also was quite healthy, and presented a little more turgescence than usual; and there were three extravasations of blood in the scalp, but without corresponding external bruise. There were some marks of violence on the limbs, considerable

effusions of blood among the muscles of the neck, back, and loins, and on the sheath of the spinal cord. The posterior ligamentous connections between the third and fourth cervical vertebræ were torn. These injuries to the back were shown to have been occasioned after death by the forcible doubling up of the body. It should be added that a "handful" of clotted blood was found near the body.

In the case of Carlo Ferrari, the victim of Bishop and Williams, the appearances from which suffocation might have been inferred were even less strongly marked. The face, it is true, was swollen and congested; the eyes bloodshot, and the lips tumid; but the lungs were quite healthy and not congested, the heart was contracted, and all its cavities quite empty. But these exceptional appearances were explained, by the fact, that the murderers, after stupefying their victim with liquor, lowered his body into a well with the head downwards, taking care to keep the mouth below the water. In this case, too, there was some extravasated blood under the scalp, among the muscles of the neck, and on the spinal cord. The fresh state of the body, the appearance of the countenance, and a wound upon the left temple, combined to excite suspicion, and led to the committal and conviction of the murderers.

In both these cases death was certainly caused by suffocation, and yet the appearance of the bodies was not such as to lead at once to the conclusion that death had happened in this way. The medical examiners, in both cases, were inclined to ascribe the deaths to the injury done to the spine, which was afterwards proved to have been occasioned after death by the forcible doubling up of the bodies in packing them.

In allusion to the opinion expressed by some medical men, that the signs of suffocation are so strongly marked as of themselves to arrest attention, Dr. Christison observes:—"In the body of the woman Campbell, no person of skill, whose attention was pointedly excited by being told that from general circumstances murder was probable, but the manner of death unknown, could have failed to remark signs that would raise a suspicion of suffocation. But if his attention had not been roused; if, for example, he had examined it in the anatomical theatre of an hospital, without knowing that suspicions from general circumstances were entertained regarding it, he might have inspected it even minutely, and yet neglected the appearances in question. Nay, a person of skill and experience would have been more likely to do so than another, because every one who is conversant with pathological anatomy must be familiar with such or similar appearances, as arising from various natural

diseases." Dr. Christison then draws attention to the close resemblance between the appearances present in the body of Campbell and those observed in the body of a man who died of dysentery, adding that the "vascularity of the conjunctivæ and the contusions on the legs made the only difference."*

* Cases and Observations in Medical Jurisprudence: 'Ed. Med. and Surg. Journal,' vol. xxxi. 243. (1829.)

CHAPTER III.

WOUNDS AND MECHANICAL INJURIES.

In this Chapter all injuries inflicted by mechanical means will be treated of, except the several forms of death by suffocation examined in previous chapters, and injuries by fire, and by lightning, reserved for separate examination in succeeding ones.

All injuries, therefore, which one man inflicts upon another, whether by cutting or bruising instruments, by his own person, or by forcing him against an obstacle, will have to be considered under this head. For the punishment of all such injuries when maliciously inflicted, the statute law makes provision, no less than for stabbing, cutting, shooting, drowning, strangling, and suffocating, by the insertion of the words "or shall by any means whatsoever wound or cause any grievous bodily harm to any person," and "by any means other than those specified," &c., and "with or without any weapon or instrument," &c. (§§ 11, 15, and 20, of 24 and 25 Vict. cap. c.)

In examining so large a subject, methodical arrangement is especially necessary. The different kinds of mechanical injury will have to be separately considered, then the questions common to all such injuries; then the way in which they affect the more important organs of the body.

Three kinds of mechanical injury will have to be separately examined:—wounds in the common acceptation of the term, gunshot wounds, and mechanical injuries not usually designated as "wounds."

The old surgical definition of a *wound** makes it to consist in a *solution of continuity*. Mechanical injuries, therefore, may be conveniently divided into such as are *without solution of continuity*

* "A wound is a solution of continuity in any part of the body suddenly made, by anything that cuts or tears, with a division of the skin." "By the word skin, I understand not only the external cutis, but also the inward membranes of the gullet, ventricle, guts, bladder, urethra, and womb, all of which are capable of wounds from sharp instruments, either swallowed or thrust into them."—Richard Wiseman's 'Chirurgical Treatises,' book v. chap. i.

and such as are *with solution of continuity*. The first will include, *contusions, concussions, simple fractures, dislocations*, and *sprains*. The second comprises *incisions, punctures*, and *lacerations, compound fractures*, and *gun-shot wounds*.

Each class of injuries, whatever the parts affected, has some points common to all the forms of violence included in the class. Thus, almost all injuries affecting the deeper-seated parts are accompanied by external traces of the force that produced them, whether it caused a solution of continuity or not. So that in most cases we shall have traces of the injury on the *surface*, and it will therefore be necessary to examine minutely the subject of bruises and incisions involving the external parts of the body.

The subject will be best examined under the following heads:—1. The characters of contused wounds, and of injuries unaccompanied by solution of continuity. 2. The characters of incised wounds, and of those accompanied by solution of continuity. 3. The characters of gun-shot wounds. 4. The questions common to all forms of mechanical injury. 5. Wounds as they affect the several important organs of the economy. 6. The detection of blood-stains on clothes, weapons, &c.

I. CONTUSED WOUNDS, AND INJURIES UNACCOMPANIED BY SOLUTION OF CONTINUITY.

A blow with a blunt instrument causes an appearance on the surface commonly known as a bruise, and, in scientific language, as an *ecchymosis*. It consists in a discoloration of the skin produced by extravasation of blood into the cellular membrane. When this happens in the superficial parts, and especially in lax and yielding portions of the skin, the colour makes its appearance at once; but when deeper seated, days may elapse before the skin becomes discoloured, and then it is not blue, as in superficial parts, but of a violet, greenish, or yellowish hue; nor is it always immediately over the extravasation.

The blue colour is not fully developed at once, but it continues to deepen for five or six hours. When blood ceases to flow from the broken vessels, serum is effused, and inflammation is set up, and thus the bruise is enlarged. Its colour also undergoes a change, passing from deep blue through shades of green, yellow, and lemon colour. After a further interval, the effused fluids are absorbed, and the colours first fade and then wholly disappear. If the injury has been severe, the inflammation runs on to suppuration, forming an abscess if deep, an ulcer if superficial.

The change of colour begins at the circumference, where the

effused fluids are scanty, and travels inwards towards the centre, where they are abundant, and where the deep blue colour often remains after the rest of the bruise has completely changed its appearance. In bruises of any extent, and in parts which contain much blood, coagula are formed.

The extent of the bruise, and the rapidity of its changes, will depend on the force used, the size and character of the weapon, the age, constitution, and health of the sufferer, the full or empty state of the vessels, and the tension or laxity of the skin. A boxer in training would scarcely be marked by a blow that would disfigure a person in ordinary health; and in severe cases of scurvy the slightest touch causes a bruise closely resembling that produced in healthy persons by greater violence.

As the form of a bruise is mainly determined by the shape of the weapon, it often furnishes strong presumptive evidence. Thus Starkie, in his 'Law of Evidence,' relates a case in which a blow on the face given in self-defence, with the key of the house door, caused a bruise which corresponded in shape to the wards of the key, and served to identify the man who had committed the assault. The subjects of death by hanging, strangulation, and suffocation, furnish good examples of this correspondence of bruises with their cause.

The discolorations which constitute a bruise are not confined to the cellular membrane, but involve more or less the substance of the true skin. Bruises are thus distinguished from cadaveric lividity. (See p. 247.)

But blows, even when very severe, do not produce marks of injury on the surface, if the parts beneath are soft and yielding. Thus blows on the abdomen, severe enough to rupture the viscera, do not always bruise the skin, though they sometimes lead to the effusion of blood between the muscles. On the other hand, when severe injuries of hard parts, such as fractures of bone, are unattended by a bruise, there is a strong presumption against their having been caused by a blow.

Can the appearance of a Bruise be produced after Death?

This question is answered by Christison's experiments, from which it appears, that, up to two hours after death, and, in rare cases, three hours and a quarter, appearances may be produced more or less resembling bruises inflicted during life; blood is effused into the cellular tissue, on the surface of the cutis, and even into its substance; and the effused blood coagulates.

Distinction between Bruises inflicted during Life and after Death.—In certain cases this distinction is easy. If there is

much swelling, any change of colour, or any sign of inflammation, the bruise must have been inflicted during life.

If on cutting into the bruise, the effusion of blood is found to be considerable, and the clots large, the presumption is strongly in favour of its having been inflicted during life. So also if the cutis is discoloured from the effusion of blood into its texture. This last is a valuable diagnostic mark, except in the case of bruises inflicted a few minutes after death, when, judging from the analogy of incised wounds, we may expect the same appearances as in those produced during life.

As the same effusion of blood, which, on the surface, gives rise to the appearance of a bruise, may, when it occurs in the deeper seated parts leave little or no trace on the surface, it is important to ascertain whether such deeper effusions of blood may take place after death as well as during life. This question too has been answered in the affirmative. In the body of Margery Campbell, the victim of Burke, there were marks of severe injury to the back, to which Christison was at first inclined to attribute her death; and semi-fluid blood was found under the trapezius muscle, near the inferior angle of the scapula, and in the cervical, dorsal, and left lumbar regions, but there was no corresponding bruise on the skin. The posterior ligaments of the vertebræ were ruptured, but there was no fracture. On the sheath of the spinal cord opposite the rupture, there was a mass of semi-fluid black blood an inch in diameter, and about the thickness of a penny; from this a thin layer of blood extended along the posterior surface of the sheath, as far as the lowest dorsal vertebra. The spinal cord was uninjured, and there was no blood under its sheath. Christison proved that all these marks of violence might be produced seventeen hours after death, by bending the head forcibly on the chest. In the body of Carlo Ferrari, also, five or six ounces of coagulated blood were found among the deep-seated muscles of the neck, from the occiput to the last cervical vertebra; and there was a large quantity of fluid blood in the upper and lower part of the spinal canal, exterior to the sheath of the cord, but no blood within the sheath, nor had the vertebræ, or their ligaments, or the cord itself, suffered any injury. The confession of the criminals showed that these injuries to the spine were produced after death. (Refer to p. 295.)

The difficulty of determining whether a bruise was inflicted during life or soon after death, will be much increased if putrefaction has set in; for it exaggerates the appearance of injury, and produces great alterations of consistence and colour; while

the pressure of the gases evolved may cause copious outpourings of blood through ruptured vessels. This was well shown in the body of a man who had died of apoplexy. The veins of both arms had been opened, but no blood had flowed during life. After death, however, an abundant hæmorrhage took place from the wounded vessels. (G.)

In a case which occurred at Paris, the effusion of blood caused by strangulation was discovered as a black mass twenty years after death. But the cord was found round the neck, and removed the difficulty which might otherwise have existed.

In respect to *fractures* the same observations apply, in nearly the same degree. A fracture produced within a short period after death, and one produced during life, but speedily followed by death, would probably present very nearly the same appearances. A fracture caused some time before death would be readily distinguished by the inflammation set up about it.

Fractures may be detected long after death. Thus, in the body of Clarke, the victim of Eugene Aram, the fracture and indentation of the temporal bone were plainly distinguished after the lapse of thirteen years.

II. INCISED WOUNDS, AND WOUNDS ACCOMPANIED BY A SOLUTION OF CONTINUITY.

Under this head are comprised incised, punctured, and lacerated wounds. Gun-shot wounds will be treated of separately. It is to incised wounds that the following observations chiefly apply.

The immediate obvious consequences of wounds with solution of continuity are hæmorrhage, and retraction of their edges: the remote effects are those of inflammation and its sequelæ. In a recent incised wound, inflicted during life, there is copious hæmorrhage, the cellular tissue is filled with blood, there are coagula between the lips of the wound, and the edges are everted. After the lapse of from eighteen to twenty-four hours there are the signs of inflammation, increased redness, swelling, and effusion of coagulable lymph.

As a rule incised wounds, whether caused by cutting or slashing, are fusiform in shape, owing to the retraction of the tissues in the middle, and especially so when muscular fibres have been divided transversely. Incised wounds usually commence abruptly and terminate gradually, or tail off. This often indicates the direction in which the instrument was drawn.

Incised wounds do not correspond in shape to the weapon with which they were inflicted, as the wound is always broader than the cutting edge.

A wound resembling an incised wound may be caused by a blunt instrument, or a fall, in certain parts of the body, as for instance, on the scalp, owing to the resistance of the underlying skull.

The chief danger of incised wounds is hæmorrhage.

Copious hæmorrhage affords of itself a strong presumption in favour of a wound having been inflicted during life, especially if the body is fresh. Scanty hæmorrhage, or the entire absence of it, as in the case of Sir Edmondbury Godfrey (p. 289), supplies an equally strong reason for attributing death to some other cause. But lacerated and severe gun-shot wounds form an exception to this rule. In the well-known instance recorded by Cheselden of a man's arm torn off by a windmill, and in a case more recently reported by Mr. Bransby Cooper, there was scarcely any hæmorrhage. On the other hand, very considerable hæmorrhage may take place after death, and especially when putrefaction is set up, if any large vein happen to be wounded.

In the case of incised, as of contused wounds, it is important to determine whether the appearances found in wounds inflicted during life may be produced after death.

Characters of Wounds produced after Death.—The experiments of Orfila on the dog have shown, that the appearances proper to incised wounds inflicted during life may be produced immediately after death; and the experiments of Dr. Taylor made on limbs recently amputated, show to what degree the resemblance may be carried.

When the incision was made ten minutes after the removal, there was immediate considerable retraction of the skin, protrusion of the adipose substance, and scanty flow of blood; and after twenty-four hours, the edges were found red, bloody, and everted; the skin somewhat flaccid; a small quantity of blood escaped on separating the edges; no coagula adhered to the muscles; but at the bottom of the wound were several loose coagula.

After the same interval of ten minutes a second experiment was performed. The edges of the wound were slightly everted; scarcely any blood escaped; and twenty-four hours afterwards the edges were pale and perfectly collapsed, and at the bottom of the wound were a few coagula.

When the wound was not made till two or three hours after the removal, a small quantity of liquid blood was effused, and no clots were found. The edges of an incised wound made twenty-four hours after death were yielding, inelastic, in close approximation, and free from coagula.

Lacerated wounds combine the characters of incised and con-

tused wounds, being accompanied with less hæmorrhage than the former, and less discoloration than the latter. The edges are generally torn, but, as above stated, though caused by blunt weapons or falls, they may be sometimes sharp and defined. They seldom correspond in shape with the instrument or material which caused them. The distinction between such wounds inflicted during life and after death is less easily made.

Punctured wounds are intermediate between incised and lacerated wounds, resembling the former when inflicted with a sharp instrument, and being often accompanied by profuse hæmorrhage; but when made with a blunt object, being more like lacerated wounds, and occasioning little loss of blood. The form depends on the shape of the weapon and on the direction of the violence. They are in general smaller than the weapon. They may resemble incised wounds if the weapon by which they are inflicted is a broad, two-edged blade. If the wound was made by a perpendicular stroke, they will correspond to the breadth of the weapon. If the blow was struck obliquely, the wound will be longer. A weapon with a thick back and a sharp edge will cause a correspondingly shaped wound. Triangular weapons, such as bayonets, cause triangular wounds.

It must be remembered, however, that the same weapon may produce differently shaped wounds on different parts of the body, according to the tissue penetrated, and the amount of retraction which ensues. The chief danger is from injury to internal organs or penetration of internal closed cavities, such as the pleura.

Sword wounds traversing the body, have a large depressed orifice of entrance, and a small and raised orifice of exit; but this condition may be reversed when the weapon is drawn out, especially if it is rough from rust or otherwise.

III. GUN-SHOT WOUNDS.

These belong to the class of contused or lacerated wounds; of contused wounds when the shot does not penetrate, of lacerated wounds when it enters or traverses the body. They are, as Wiseman observes, "the most complicate sort of wounds;" they combine "contusion, attrition, and dilaceration" in a high degree; they occasion "all sorts of fractures;" they introduce extraneous bodies; and they give rise to hæmorrhage, inflammation, erysipelas, gangrene, and sphacelus. The lips of a gun-shot wound are "livid or blackish:" they become the seat of inflammation and swelling; and "blisters frequently rise about them," containing "matter of a fœtid smell."

Gun-shot wounds caused by discharges close to the person are

"burnt by the flame," and they may contain particles of unconsumed powder. If covered by clothes, these also may be blackened or burnt. As a general rule gun-shot wounds, unless they injure some large vessel, do not give rise to much haemorrhage; but the destruction of parts from the sloughing and suppuration that follow them, often occasions profuse and fatal discharges of blood.

The bullet, shot, or wadding discharged from fire-arms at short distances sometimes lodges in the body, sometimes traverses it. When it lodges, it often furnishes conclusive evidence. The bullet may prove to have been cast in a mould, or the wadding to be formed by printed paper or other material, in the possession of the person who fired the shot. It may even happen that the composition of the bullet, or the mode of making it, is peculiar. In medico-legal cases, therefore, the contents of a gun-shot wound should be carefully examined, and preserved. When the bullets traverse the body, the two apertures should be carefully examined. The aperture of entrance is round and clean, that of exit less regular in shape and jagged. On entering the body "the bullet forces the flesh in with it, and the place by which it enters presently contracts closer; but its going out is more lax." The same difference of entrance and exit is seen in the clothes. Such is generally the case, but the rule is by no means absolute. Much depends on the velocity of the bullet and the amount of resistance it meets with in its passage through the tissues. And in reference to the effect of conical bullets, which are now generally used, a distinction between the aperture of entrance and that of exit is extremely difficult. For, as a general rule, both apertures are of much the same size and have a somewhat triangular shape. This is so even when very extensive destruction of deep parts has been caused by the passage of the projectile. Bullets that strike the body obliquely produce a valvular wound.

Bullets which lodge in the body are often turned out of their direct course by contact with a bone, or other firm resisting structure. Thus (to give examples from the practice of Richard Wiseman) a bullet entered the cheek and was cut out from the back of the neck; a second, entered the outside of the small of the leg, and was found on the inside of the thigh above the knee; and a third entered the outside of the arm, and was cut out below the scapula. In some cases, the bullet has struck the head or abdomen, and after traversing the half-circumference of the part, has been found lodged, or to have passed out at, the opposite point. Again, bullets may be split into two or more fragments by striking a bone, and these fragments may either traverse the

body or lodge in it. If they lodge, they may be found to have taken the same eccentric course as the undivided bullet in the cases just cited: if they traverse they may occasion more than one wound of exit resembling that caused by a single bullet.

When the bullet takes a direct course through the body (that is to say, when it is not deflected) the character of the two apertures, coupled with the direction of the line which joins them, may serve to indicate the posture of the body at the time the wound was received. So also when a bullet, after traversing a wooden paling, or a window, strikes a wall beyond, the line of flight, and spot from which the shot was fired, may be determined.

Small shot discharged quite close to the body, and striking it at right angles, may cause a round clean wound not easily distinguished from one produced by a bullet; but at the distance of a foot or more the shot scatter, and occasion an irregular wound. At the distance of three feet the shot are so much scattered that it is not possible to confound the injury with one caused by a bullet. In these wounds some of the shot lodge in the body, and when fired close, or within a short distance, there will be marks of burning on the skin and clothing.

Fire-arms loaded with wadding, and fired close to the body, or within a few inches, may produce severe, and even fatal, penetrating wounds, and even at the distance of a foot may give rise to extensive superficial injuries. The unconsumed powder, when fire-arms loaded only with powder are discharged close to the body, may produce the same injuries as small shot.

From what has been said above of the complicated nature of gun-shot wounds, it is obvious that they are very dangerous to life. They may prove fatal, immediately, or within a short interval, by shock, or hæmorrhage, and after a longer interval, by secondary hæmorrhage, by erysipelas, by tetanus, or by the inflammation and extensive suppuration following on the death of the injured parts.

The same medico-legal questions, such as the more or less dangerous character of the wound, the effect of the treatment adopted, and of the subsequent conduct of the wounded person, on the issue of the injury, and the amount of locomotion possible after it, arise in gun-shot as in other wounds.

The question whether the wound was the result of *accident*, *suicide*, or *homicide* may also be raised respecting these in common with other wounds. As a general rule, accidental wounds, whether inflicted by the wounded person, in loading, or in the act of carrying a loaded piece, or by another person pointing at him a piece

supposed not to be loaded, or walking or shooting in his company have the characters of wounds caused by discharges near the person; but these characters they have in common with suicidal wounds. But suicidal wounds have the character which accidental wounds often, and homicidal wounds sometimes, lack, of being inflicted in front on the head or region of the heart. To this rule, however, some suicidal gun-shot wounds form an exception, inasmuch as the weapon is directed to the back of the head. As a general rule, too, the suicide fires only one shot; but suicides have been known to fire two pistols, and even to resort to fire-arms after the failure of incised wounds. In some cases the suicide is found in a room secured from within, with the weapon still grasped in the hand, and when the priming was of powder, with the hand stained by it.

Some advantage is occasionally derived from an examination of the gun or pistol. When the combustion of the powder is imperfect, the finger introduced into the barrel is blackened by the unconsumed charcoal; and the residue is found to consist of this unconsumed charcoal mixed with sulphide of potassium. But when the combustion is perfect the finger is not blackened, for the residue consists of the white sulphate and carbonate of potash. After an interval of some days, varying with the quantity of moisture in the air, the mixed residue of charcoal and sulphide of potassium is converted into sulphate, which after a still longer interval may be found blended with the rust of iron.

IV. QUESTIONS COMMON TO ALL FORMS OF MECHANICAL INJURY.

There are three questions common to all forms of mechanical injury:—1. *Was it inflicted during life?* 2. *Was it the cause of death?* and 3. *Was it accidental, suicidal, or homicidal?* The first question has been already examined; the second and third remain to be discussed.

Was the Wound the cause of Death?—The answer to this question rarely presents any difficulty when a man in the enjoyment of perfect health receives a severe injury, and dies before sufficient time has elapsed for disease to set in, or neglect, or unskilful treatment to prove injurious. But when a considerable interval elapses between the receipt of the injury and the fatal event, such complications may arise, and render the answer to the question difficult.

To the first class of cases belong the abnormal formation of the parts injured (as in the instance of a boy caught robbing an orchard, whose death was caused by a blow intended as a simple chastisement, on a skull preternaturally thin), and their abnormal

mation (as in the familiar instances of an inguinal hernia in-red by a kick; of fatal hæmorrhage caused by a blow on the ins over the seat of a kidney containing a jagged calculus; and a large abscess behind the ear ruptured by the same means).

To this class also belong those sudden deaths which follow falls blows too slight to account for the fatal result by the direct jury they occasion, death being really caused by the rupture of vessel on the brain, or of an aneurism; in both which cases it possible to attribute the death to the excitement of the struggle well as to the fall or blow. Also those cases of latent effusion the brain or into the cavities of the chest which might prove ddenly fatal even in the absence of violence, but are very likely cause death under the influence of excitement or shock.

In these cases the injury is inflicted in ignorance of the exis-nce of any cause by which, though comparatively slight, it ight be rendered mortal. To all other cases, such as those of ung, feeble, or aged persons, and pregnant women, the Eng-h law, as laid down by Lord Hale, will apply: "it is sufficient prove that the death of the party was *accelerated* by the alicious act of the prisoner, although the former laboured under *mortal* disease at the time of the accident."

The second class, or that in which an interval elapses before e wound proves mortal, comprises a greater number of special ses. Before treating of these in detail, it is necessary to pre-ise that even when the interval between the injury and the tal result is considerable, it may be quite possible to attribute e death to the injury without any misgiving; for it may be ch that no strength of constitution, and no care or skill, could vert a fatal termination. In fractures or dislocations of the ine, for instance, and in gun-shot wounds when the bullet dges in the body, however long the fatal result may be post-oned, the death is fairly attributable to the injury alone. But ough, in cases of this kind, no doubt can exist either respecting e true cause of death, or the guilt attaching to the act of vio-nce, the lapse of time has, in most civilized countries, been ken into account, and by the common law of England, if the jured party survive one year and one day, the crime ceases to murder; and English juries have sometimes shown a disposi-on to shorten this period very considerably.

Within this period of 366 days there is ample opportunity for me of the circumstances now to be specified to come into play.

1. A trifling wound or injury may prove fatal, from the in-red part taking on an unhealthy character, such as scrofulous

inflammation due to peculiarity of constitution, or erysipelatous inflammation from exposure to contagion.

2. To the same class of cases belong attacks of fatal tetanus, or of delirium tremens from slight injuries, as well as rare instances of pyæmia from latent abscess brought into activity by a fall or blow, and fatal diseases of internal organs arising independent of, but soon after, the injury.

3. Another circumstance bearing on the question, Was the wound the cause of death? is the improper management of the wounded party, whether consisting in the neglect of medical assistance, or of medical instructions; or in the resort to ignorant and unqualified practitioners, or in irregularities, misgovernment, and reckless exposure to cold, fatigue, or fresh injury, or to intoxication, on the part of the patient himself; or in *male praxis* on the part of a qualified medical attendant.

Was the Wound Accidental, Suicidal, or Homicidal?—Accidental death is a common occurrence in crowds, and in wrestlings and fights, when the deceased person falls, or is thrown, or struck against, hard resisting objects, in which case an examination of the spot will help to determine the question.

There is always a probability of accident when a body is found in a dangerous situation, as at the foot of a precipice, or in a river with steep banks; and the probability is increased when the deceased is proved to have been drinking. In all doubtful cases the character of the injuries will go far to determine the class to which the death belongs. Bruises, fractures, and dislocations, for instance, are more consistent with the theory of death by accident than incised, punctured, or lacerated wounds.

If we suppose the alternative of accident to be excluded by the nature of the case, the original question is narrowed to this, *Was the wound suicidal or homicidal?*

As suicide is much more common than homicide, there is always a *primâ facie* probability in favour of suicide, especially in middle-aged persons; but this probability will be materially modified by such considerations as, the place in which the body is found; the nature, seat, extent, and direction of the wound; and the number of wounds.

Place where the Body is found.—The finding of a corpse in a room with the windows and doors fastened on the inside, is conclusive of suicide. The absence of the instrument of death is conclusive as to murder. So also, if the blood from a mortal wound has been washed from the body or floor, or the body itself has been placed in a position inconsistent with the mode of death, or covered, or buried.

Nature of the Wound.—*Contused wounds* are rarely suicidal, though attempts at self-destruction by knocking the head against the wall are not uncommon. Severe contusions, therefore, are most probably homicidal, unless the body is lying near a height from which it might have fallen, or from which the deceased might have thrown himself. *Incised wounds* are as likely to be suicidal as homicidal, and it is not easy to infer from the character of the wound to which class it belongs. The cleanness and evenness of an incised wound have, indeed, been thought to afford a probability in favour of homicide, but without sufficient reason; for a resolute suicide is more likely to have a steady hand than a murderer to meet with no resistance; and some of the deepest and cleanest wounds of the throat are certainly suicidal.

In a few instances the *shape* of an incised wound helps us to determine the question of suicide or homicide, by indicating the kind of instrument with which it was inflicted, and the occupation of the murderer. Thus, a man with his throat cut from within to without, as butchers slaughter sheep, was found to have been murdered by a butcher; and in the case of a body divided into two parts by a cutting instrument passed into the fibro-cartilage uniting the third and fourth lumbar vertebræ, so as to divide the articulating processes transversely, as butchers cut through the spines of animals, a butcher was proved to have been the murderer. (Orfila).

Situation of the Wound.—It may be laid down as a general rule, that if a wound is so situated that the instrument of death, when placed in the hand of the deceased, cannot be made to reach it, whether by the motion of the hand itself, or by that of the part injured, or by both jointly, it was not self-inflicted. Wounds on concealed parts of the person, as within the labia, and beneath the breast of the female, are in all probability homicidal. It must, however, be borne in mind that while murderers sometimes inflict injuries of a kind to appear suicidal, many suicides are moved by very eccentric impulses.

Extent of the Wound.—It has been thought that a suicide would not have courage or strength to inflict a very extensive wound upon himself; but experience is opposed to this view. Suicidal wounds of the throat, for instance, are usually deep and extensive; and nothing is more common than to read of the head being nearly severed from the body. But superficial wounds of the throat are among the most common forms of pretended suicide.

Direction of the Wound.—Suicidal wounds generally follow the natural movement of the arm from left to right, and from

above to below. But in the case of left-handed persons, the direction would be reversed. Wounds of the throat, whether suicidal or homicidal, are, however, generally transverse. When persons of different statures fight together, a wound inflicted by the taller man would pass from above downwards, and the reverse if given by the shorter, supposing both combatants to maintain the erect posture. In wounds inflicted by a sword, or by fire-arms, it is always important to notice both their direction and the orifices of entrance and exit.

Number of Wounds. The coexistence of several mortal wounds affords a presumption against suicide, but only a presumption; for after inflicting on themselves wounds necessarily mortal, suicides have retained strength and determination to inflict others. Thus Orfila relates the case of a gentleman at Rouen found dead in his chamber, with two pistols lying, one near the body, the other on the bed, at some distance from it. He had shot himself in two places. One wound, apparently made while he was on the bed, had traversed the left side of the chest, breaking a rib before and behind, perforating the middle portion of the lung, and passing near the roots of the pulmonary veins. A large quantity of blood was extravasated in the chest. After inflicting on himself this serious injury, the deceased must have risen from the bed, walked to a closet to get another pistol, with which he produced a second wound that must have killed him instantly. The ball had entered the frontal bone, and, after traversing the left hemisphere of the brain, had lodged against the os occipitis. There was no doubt of this having been a deliberate suicide.

Watson gives a case of suicide in which no less than ten wounds were inflicted on the throat.

It is scarcely necessary to observe that most of the probabilities just established may lead to error if too implicitly relied upon; so that in doubtful cases we must guard against false inferences from circumstances purely accidental as well as from arrangements made to deceive us.

Nor is it always safe to assume that a severe injury, actually inflicted by another, is the real cause of death; for, as in a case related by Wildberg, a death occurring during a chastisement may, on examination, be found to have been due to poison.

The *circumstantial evidence* in death by wounds is of great importance. *See* "persons found dead" (p. 234). Thus Sellis, a servant of the Duke of Cumberland, afterwards King of Hanover, was found dead on his bed with his throat cut, while his master, severely wounded in the head and hand, was under the care of Sir Everard Home. The Duke stated that he was roused from

sleep by a blow on the head, followed by several others, one of which caused an immense effusion of blood; that he leaped out of bed, and followed his assailant, who repeatedly struck at him, and would doubtless have murdered him, but that the doors protected his person from some of the blows. Every part of this statement was confirmed by the circumstantial evidence. The coloured drapery at the head of the Duke's bed was sprinkled with blood; there were traces of blood on the passages and staircase, and on the doors of all the state apartments; and Sellis's coat was found on a chair out of reach of blood from his bed, but with the sleeve sprinkled from shoulder to wrist "with blood, quite dry, and evidently from a wounded artery."

Lord William Russell, the victim of Courvoisier, was found dead in bed with his throat cut; the instrument of death did not lie near the body, and a napkin was placed over the face. A woman of the name of Norkott was found dead in bed with her throat cut, and on her *left hand* a bloody mark of a *left hand*. In both these cases the evidence of murder was complete.

There are still other questions that may have to be considered. We may be asked whether a given wound is dangerous to life, and, of many wounds, which was mortal. It may also be important to know how long the wounded person survived the injury, and to fix the point of time at which a wound was inflicted.

Is the Wound dangerous to Life?—This question is easily answered in the case of injuries to large blood-vessels and important viscera, but less easily in the case of injuries which affect life rather by their extent than the importance of the parts implicated; for while, on the one hand, slight injuries to parts altogether unimportant may, in peculiar states of constitution, prove fatal, on the other, recovery may take place from injuries the most severe and extensive, as in the well-known case of Mr. Tipper, who was pinned against a stable-door by the shaft of a gig traversing the chest.

The danger attending injuries of the several important parts of the body will be found discussed under the next heading.

Of many Wounds, which was mortal?—It is easy to understand how this question may become important. A mortal struggle may begin with blows and end with the use of a stabbing or cutting instrument; and the crime would have a very different aspect, according as the death was attributable to the blows or to the stabs or cuts. The question is of so general a nature that it must suffice to indicate its importance.

How long did the wounded person survive?—This question,

too, may evidently assume importance, especially in connexion with the amount of exertion possible after severe injuries. As one involving many details, it must be reserved for the next division.

When was the Wound inflicted?—This question may arise either during life or after death. During life the question must be answered, in the case of contused wounds, by the extent of the ecchymosis and the colours it assumes; in the cases of incised and punctured wounds, by the state of the divided parts, whether they are filled with extravasated blood or not; and whether the edges are swollen, and the surrounding skin inflamed. After death the question either resolves itself into the simple inquiry, How long has the deceased been dead? or into the double question of the date of the death and the length of time that the deceased survived the injury. The presence or absence of animal heat, of cadaveric rigidity, and of putrefaction, and the progress which putrefaction may have made, must be taken into account. These changes in the condition of the dead body take place, as has been already observed (p. 242), with very different degrees of rapidity in different subjects; so as to oblige us to speak of the time occupied by them with caution and reserve.

V. WOUNDS AS THEY AFFECT THE SEVERAL PARTS OF THE BODY.

Some of the questions which have been indicated as important in the previous division, will be examined in detail in this.

Wounds of the Head.—Injuries to the *scalp* are more important than those of the integuments of other parts, on account of the peculiar tendency of the skin itself to take on the erysipelatous inflammation; the quantity of loose areolar tissue intervening between the tendon of the occipito-frontalis and the periosteum, which is very liable to become the seat of diffuse inflammation; and the relation of the tendon to this lax tissue, preventing, as it does, the escape of effused products. Punctured and contused wounds of the scalp are dangerous on account of the inflammation they set up in this tissue, and the want of free exit for the discharges. But extensive lacerated wounds which do not involve the periosteum are rarely serious, inasmuch as they afford free passage to the products of inflammation.

Fractures of the Skull are not more important than those of other bones, unless the force that occasions the fracture also produces concussion, or other injury to the brain, or its membranes. It should also be understood that a blow does not

always fracture the bone on which it alights, but may produce a counter fracture at an opposite part of the skull. A severe blow or fall on the vertex of the head, for instance, will often occasion a fracture at the base.

In estimating the danger attending fractures of the skull, we must bear in mind the different thickness of its several parts. Thus, a blow on the temple would be productive of greater injury than one of equal force applied to other parts of the cranium; the orbitar plate by its extreme thinness exposes the brain to serious injury from thrusts with pointed instruments; and the cribriform plate of the ethmoid bone would be easily fractured, and the base of the brain injured by a sharp-pointed instrument thrust up the nostril.

Injuries of the Brain fall under the distinct heads of concussion, compression, wounds, and inflammation.

Concussion.—This is a common effect of severe blows or violent shocks. The symptoms often follow immediately on the accident, and death takes place without reaction, or any improvement under treatment. The two states of concussion and compression may be combined, and concussion may be followed by compression or inflammation.

Concussion is not always attended by lesion of the brain. Thus, Mr. Travers, in his work on 'Constitutional Irritation,' gives the case of a prize-fighter who was taken off the ground insensible, and apparently apoplectic, and died in eight hours; yet no lesion or extravasation could be discovered.

The interval between the receipt of this form of injury, and the fatal termination, is very various. It may prove fatal, as in the case just quoted, in a few hours, or after the lapse of several days, weeks, or even months. Thus Richard Wiseman, in his chapter on Wounds of the Head, gives the case of a lady who received a blow on the head while riding under a pent-house. The blow stunned her, and she died after many months of suffering with symptoms pointing to cerebral abscess.

It is a remarkable circumstance connected with this class of injuries, that the patient sometimes suffers little or no immediate inconvenience; but, after the lapse of some days, is seized with symptoms of compression or of inflammation. Thus, Mr. Pott gives the case of a woman who received an injury on the head, and after remaining well twelve days, fell ill, and died with symptoms of compression. The ventricles contained bloody serum, and a small coagulum. And Abercrombie gives the case of a girl, aged thirteen, who fell from a swing, and struck her head violently against the ground. For six weeks after the accident she com-

plained of headache, but was not otherwise ill. Feverish symptoms then came on, followed by slight delirium and coma, and she died two months after the fall. Distension of the ventricles with serous fluid was the only morbid appearance.

Compression.—This may be caused by depressed bone, or by effused blood or serum. The symptoms come on suddenly or gradually, according to the nature of the compressing cause, and the fatal result follows in varying intervals of time. In compression due to depressed bone, the cause of death is obvious; but when it arises from effusion of blood or serum following an injury, it may be alleged that the effusion and consequent fatal result were due, not to the injury itself, but to some concomitant circumstance. Thus, if in the course of a struggle a man is thrown down or struck, and dies soon after, with symptoms of compression, and an effusion of blood has taken place, this may be attributed to the excitement of the contest, and not to the injury itself; and this is more likely to be the case if the deceased was given to habits of intoxication, or was of a plethoric habit and apoplectic make, or of an advanced age. The inquiry will be still more difficult, if on dissection the vessels of the brain are found diseased; but as sanguineous effusion rarely takes place *on the surface of the brain* from disease, the difficulty will only attach to effusions at the base, in the ventricles, or into its substance.

Wounds.—These present considerable difficulty in a medico-legal point of view—a difficulty well set forth in the words of Richard Wiseman. He says, "the greater symptoms that are usually said to attend the wounds of the brain do show themselves more uncertainly than a speculative chirurgeon would imagine; and in cuts and wounds made by sharp weapons or sudden strong force, more uncertainly than in contusions, concussions, and depressions of the skull; the highest of them, viz., vomiting, stupor, loss of spirits, with a paralysis of legs and arms, arising more suddenly in these latter cases than in the former." "Nay, we see many die suddenly from a box on the ear, and from small blows or wounds. In some whereof, upon opening the cranium, there hath been much blood extravasated: in others none at all, or aught else that may be thought to have killed the patient." "Others I have been called on to see opened, when there had preceded only a contusion of the calvaria, without any fissure, or more extravasated blood than is usually seen in every opening on taking off the cranium: yet the patient lay, as I am informed, under all those symptoms of delirium, coma, &c. Then, again, I have dressed many that have been cut through the skull,

the shivers of bones lying pasht with the flesh and hair upon the dura mater: yet the patient hath been without any symptoms of such a wound; which I suppose happened by reason of the bones lying loose upon the membrane."

Of severe symptoms quickly following a slight injury the following is an example:—A young man received a blow on the forehead from a cudgel, soon took to his bed and became delirious: a sopor followed, and after some days he died. A small hair-like fissure was found running from the great canthus of the eye upward. On removing the skull and dura mater but little blood was found extravasated, and the pia mater little altered. Of comparatively slight symptoms following very severe injuries, the following is an example of the opposite kind from the same author:—A soldier was shot in the face by a case-shot, and had "his face, with his eyes, nose, mouth, and forepart of the jaws, with the chin shot away, and the remaining parts of them driven in. One part of the jaw hung down by his throat, and the other part pushed into it. I saw the brain working out underneath the lacerated scalp on both sides between his eyes and brows." Yet this man, after being carried off as dead, was found next morning knocking against the door of the room in which he had been placed, and was seen standing by the door. He was quite sensible, implored help by signs, and assisted himself to drink. His wounds were dressed, and he remained under Wiseman's care six or seven days, being left alive at the end of that time. An equally remarkable case, illustrating the power of locomotion that may survive very severe injuries of the brain, is related in the voyages of the great French surgeon, Ambrose Paré. "A soldier in my presence gave to one of his fellows a stroke with an halbard upon the head, penetrating even to the left ventricle of the brain, without falling to the ground." After being dressed "he returned all alone to his lodgings, which was at least 200 paces distant." The third day he came staggering to Paré's tent to be dressed, but died under his hands in a convulsion. Paré says: "I have recited this history as a monstrous thing, that the soldier fell not to the ground when he had received this great stroke, and was in good senses even till death."

Other striking cases of the same kind are to be found in the works both of Paré and Wiseman. The following is a more modern case. Thomas Fothergill was charged before Mr. Justice Willes at Newcastle with the wilful murder of John Smith. The prisoner knocked the deceased down by a blow on the head with a pickaxe, and then struck him again with the pickaxe on the body. After a time the deceased was able to walk to his lodg-

ings, whence he was taken to the Newcastle Infirmary, where he died ten days after. The temporal bone had been driven in and had lacerated the brain; and the spleen was found torn. Either injury was sufficient to cause death.

Inflammation.—This may follow injuries, not only to the organ itself, but to the scalp, and the parts most nearly connected with the brain, such as the orbit and ear. Its severity is not always proportioned to the injury received. A slight injury may give rise to very severe inflammation, a severe injury to very slight effects. The period at which inflammation sets in is also very variable. As a general rule, it does not directly follow the injury, but several hours, some days, or even weeks may elapse before it takes place.

Injuries of the head, then, have this peculiarity, that at first they often seem of little consequence, but after an interval often considerable, dangerous symptoms may arise and end fatally. Railway accidents often give rise to difficult questions relating to this class of injuries. The symptoms of injury to the nervous system have not shown themselves at once, but the following day, or after a still longer interval, and much difficulty has been experienced by the jury in awarding damages, in consequence of conflicting medical opinions. In the interval between the receipt of the injury and the accession of dangerous symptoms, there is room for neglect or mismanagement, on the part of the patient, his friends, or the medical attendant, which may materially affect the question,—Was the injury the cause of death?

Injuries to the Spinal Cord.—This, like the brain itself, is subject to concussion; to compression, from effusion of blood on its surface or in its substance; and to wounds from fractured vertebræ. Concussion and compression may follow severe shocks, as in railway accidents; the more severe injuries arise from falls or blows, or sudden twisting movements of the neck. Injuries to the substance of the cord generally prove fatal, the interval varying according to the degree of violence and the part of the spine that has been injured. Serious injury to the upper part of the cord proves immediately or speedily fatal by paralysing the muscles of respiration; injuries to the cord opposite the lower cervical vertebræ (the fourth, fifth, sixth, and seventh) prove fatal in from four or five hours to as many weeks or months: in rare instances not till the lapse of years. In the case of John Carter, of Coggeshall in Essex, displacement of the last three vertebræ with pressure on the cord opposite the seventh vertebra, did not prove fatal for fourteen years. When the cord is injured in the dorsal or lumbar region there is loss of power and sensation

in the parts below the seat of injury, with retention of urine and loss of power in the sphincter ani, requiring constant medical aid and careful nursing. With these aids life may be prolonged for years. Many injuries to the brain principally affect its base, and by causing pressure on the medulla oblongata impair the functions of the nerves supplying the muscles of respiration.*

Wounds of the Face.—These injuries not only occasion disfigurement, but, in consequence of the free distribution of important nerves over the face, still more grave inconvenience. From the near proximity of the principal features to the brain, there is also a risk of injury to that organ, as well as of inflammation extending from the seat of the wound. In this respect wounds of the face rank next in importance to those of the scalp.

Wounds of the Throat.—These are important from their frequency. They are the chosen mode of death with a great majority of suicides, and sometimes a murderer inflicts a wound on the same part, hoping that his victim will be supposed to have committed suicide. The degree of danger depends on the parts implicated. Wounds of the anterior part of the throat are less dangerous than those of the side of the neck; those of the lower part of the throat, less so than those of the upper part. A division of the carotid artery is almost necessarily fatal, and that of the internal jugular vein attended with great danger from hæmorrhage, from the introduction of air into the circulation, and from phlebitis. Wounds of the larynx or trachea are attended with comparatively little danger, and those of the trachea are less important than those of the larynx.

The question, Was the wound the cause of death? is easily answered, but the question, Was the wound suicidal or homicidal? is less easy of solution. There is also a question of considerable interest relating to wounds of the throat, namely, What amount of voluntary motion is possible after the receipt of a severe wound?

The questions of suicide or homicide, and of the amount of voluntary motion possible after a severe wound in the throat, were raised in the case of Captain Wright, who shared the captivity of Sir Sydney Smith and his celebrated escape from the Temple, and who had the misfortune to be taken a second time and imprisoned in the same place. He was found dead in his bed with his throat cut, and the razor closed in his right hand.

* For a group of cases of injury to the cervical portion of the spinal cord, consult 'Lancet,' July 19, 1856, p. 85. See also 'On Concussion of the Spine,' a clinical lecture by Mr. Skey, 'Lancet,' Jan. 10, 1857.

There was an extensive transverse wound on the anterior and superior parts of the throat, above the bone of the windpipe, cutting through the skin, the muscles, the windpipe, the gullet, and the blood-vessels, and penetrating to the cervical vertebræ. The circumstances of the case are involved in so much mystery that it is impossible to determine by the evidence collected with great pains by Sir Sydney Smith, whether Wright really committed suicide or not. But that the mere fact of the razor being found closed in his hand does not militate very strongly against the supposition of suicide, is shown by the cases that follow. In September, 1838, an officer in the army was found dead, with the head nearly severed from the body, and there was no doubt that the act was suicidal; yet the razor had been put on the dressing-table. A madman, after inflicting a severe wound on his throat had time to struggle with the maid-servant before he fell down dead. In October, 1833, a man cut his throat with a razor while walking along Oxford Street, dividing the carotid artery and several of its branches, the jugular vein of one side, and the trachea; yet he was seen to hold a handkerchief to his neck, and run four yards before he fell dead on the pavement. He held the razor firmly grasped in his hand.

In the remarkable case of Mary Green, murdered in 1832 by John Danks, the confession of the culprit, and the circumstantial evidence coincided to prove that, after a wound which divided *the trunk of the carotid artery, and all the principal branches of the external carotid, with the jugulars*, she must have risen from the ground, run a distance of *twenty-three yards*, and climbed over a low gate. It required at least from fifteen to twenty seconds to run from the spot on which the murder was committed to that on which the body was found.

Wounds of the Chest.—Incised wounds of the walls of the chest are not dangerous; but severe blows often prove fatal by the shock they occasion, or by causing fracture of the bones, and consequent injury of the internal parts, such as rupture of the viscera, leading to hæmorrhage or inflammation. Such injuries are common in prize-fights, in falls from great heights, and from heavy objects crushing the chest. Penetrating wounds of the chest can scarcely fail to injure some important organ, occasioning thereby fatal hæmorrhage or severe subsequent inflammation; but cases are recorded of sword and gun-shot wounds traversing the chest without causing any bad symptoms; and most of the cases of injury to the chest that were under Wiseman's care after the battle of Dunbar seem to have recovered.

Wounds of the Lungs.—Hæmorrhage is the immediate conse-

quence of these injuries. The blood may be discharged by the wound, or by expectoration, or it may accumulate in the cavity of the pleura, causing great difficulty of breathing. When the large vessels are wounded the hæmorrhage is copious and speedily fatal. Injuries to the substance of the lung itself are not necessarily fatal, for patients have recovered after removal of a portion of the lung, and, in rare instances, foreign bodies, such as bullets, have remained in the lung for years, and have been inclosed in a cyst. Inflammation is a common consequence of these wounds, especially when a foreign substance has been introduced, as happens in injuries with fire-arms. Cases of wounds of the lungs require careful management, and long-continued rest, without which injuries that have been repaired may be reproduced. Emphysema is a familiar effect of these wounds; but when judiciously treated it does not materially increase the danger.

Wounds of the Heart.—Penetrating wounds of the heart are speedily fatal from hæmorrhage, unless they pass so obliquely through the parietes that the flap acts like a valve, or a foreign body happen to plug the orifice. Death may be delayed in these cases, for some hours or even days. The date of the death will depend on the situation of the wound, wounds of the base proving more speedily fatal than those of the apex, and superficial wounds dividing its nutrient vessels less promptly than those that penetrate its cavities. John Bell gives the case of a soldier, in whom the apex of the heart was cut with the point of a very long and slender sword; and yet this soldier lived twelve hours, during which time, as appeared after his death, the heart had, at every stroke, been losing a small quantity of blood, till it entirely filled the chest, and the patient died suffocated. Another man was wounded with a sword, the point of which cut the coronary artery; but it was two hours before the pericardium filled with blood, and then, after great anxiety, the patient died.* In very rare instances, when the wound does not prove fatal by hæmorrhage, complete recovery takes place; as in a case related by Fournier, and authenticated by M. Mansen, chief surgeon to the hospital at Orleans, of a patient who died after the lapse of six years from the date of a gun-shot wound, from disease unconnected with it, and the ball was found embedded in the heart. MM. Ollivier and Sanson have collected a number of cases of penetrating wounds of the heart, with a view of determining the probable period at which they prove fatal. Out of twenty-nine cases of wounds of the cavities only two were fatal within forty-

* 'Principles of Surgery,' vol. i. p. 498.

eight hours. In the remainder, death took place in periods varying from four to twenty-eight days.*

Wounds of the Aorta and Pulmonary Artery are necessarily fatal; but patients have lived a few days after small punctured wounds even of the aorta.

Wounds of the Œsophagus and Thoracic Duct.—Such injuries are necessarily rare from the great depth at which these parts lie. They would be dangerous from the extravasation of their contents. Orfila, however, mentions a case of recovery from a bayonet-wound of the œsophagus.

Wounds of the Diaphragm.—Punctured wounds of this part do not appear to be attended with great danger, when they do not involve injury to the parts above or below. Hernia of the stomach (an occasional result) has proved fatal. Rupture of the diaphragm from severe blows or falls is not uncommon; and in most cases is attended by fatal shock to the nervous system, and sudden death. But death may take place after a long interval from the protrusion of the viscera of the abdomen into the chest, and the consequent disturbance of the functions of the displaced organs.

Wounds of the Abdomen.—Incised wounds of the abdominal walls may divide the epigastric artery, and so prove fatal. In wounds of the tendons as in scalp wounds, danger may arise from the accumulation of matter beneath them. Ventral hernia is a remote consequence of wounds of the walls of the abdomen. Severe blows often prove fatal by shock, hæmorrhage from ruptured viscera, or inflammation. The liver and spleen are the organs most liable to rupture.

Wounds of the Liver.—Deep penetrating wounds of this organ are apt to prove fatal by dividing the large vessels. In other cases dangerous inflammation follows. Wounds of the gall-bladder prove fatal by causing effusion of bile, and consequent peritonæal inflammation.

Wounds of the Spleen.—Deep wounds are fatal by hæmorrhage; but recovery may take place from superficial wounds. Rupture of the spleen from blows proves fatal, according to the amount of injury, in from a few hours to several days. In a convalescent patient, a kick over an enlarged and extremely soft spleen caused the effusion of several ounces of blood, and death in a few minutes.†

Wounds of the Stomach.—These kill by shock; by hæmorrhage from the large vessels; by the extravasation of the contents and consequent peritonæal inflammation; and by inflammation

* 'Dict. des Sciences Médicales,' art. *Cas rares.*
† Robert Williams, 'Elements of Medicine,' vol. ii. p. 470.

of the viscus itself. But they are not always fatal, and many cases of recovery are recorded, even when the wound was extensive, and inflicted on a stomach distended with food.

Wounds of the Intestines.—These prove fatal like those of the stomach by hæmorrhage, by discharge of contents, and consequent peritonitis, or by inflammation of the part itself. The danger is greater in the small than in the large intestines, and greatest in the duodenum, from the more fluid state of their contents, and greater risk of extravasation. In the absence of extravasation, wounds of the intestines sometimes heal by the effusion and organization of coagulable lymph about their edges.

Wounds of the Kidneys.—The kidneys may be injured by blows and stabs in the loins. Penetrating wounds may cause fatal hæmorrhage, extravasation of urine, or inflammation. If the urine can be prevented from being effused into the peritonæal cavity, recovery may take place.

Wounds of the Bladder occasion dangerous extravasation of urine, especially when the organ is distended; or they prove fatal by the inflammation to which they lead. After rupture of the bladder, the sufferer may be able to walk some distance; but the accident proves ultimately, though not speedily, fatal.

Wounds of the Genital Organs.—A removal of the penis, if not fatal by hæmorrhage, is not dangerous; but an incised wound of the urethra entails the risk of extravasation of urine and fatal sloughing. The removal of the testicles is attended with less danger than a contusion, which sometimes proves fatal by shock. Wounds of the spermatic cord occasion dangerous hæmorrhage. The complete removal of all the parts of generation of the male may lead to no bad result. Deep wounds of the labia of the female are dangerous from hæmorrhage. Fatal injuries have been inflicted on the uterus, bladder, or rectum, or on the large vessels of the pelvis, by instruments introduced into the vagina.

Consult Watson's 'Medico-legal Treatise on Homicide.'

VI. DETECTION OF SPOTS OF BLOOD.

The medical jurist may have to examine red spots supposed to be caused by blood on wearing apparel, on cutting instruments, on floors or furniture, or wherever they may have fallen; also, in some cases, to examine solutions of blood in water: and he may be asked to assign the source whence the blood, if human, has flowed, and to distinguish human blood from the blood of animals.

When the blood-spot is recent, and the quantity considerable,

it presents highly characteristic appearances, and yields a solution of a peculiar colour, readily distinguished from all other red fluids by its chemical, microscopical, and spectroscopical properties. But when the spots are not recent, and the quantity of blood is inconsiderable, greater care is needed in the work of identification.

We will first describe the characters of the above tests, and their reactions and indications, and then their application to the detection of stains.

1. *The Chemical tests.*—These have reference to *hæmaglobin*, which forms the colouring matter of the blood. The colouring matter is completely soluble in cold water, and the solution thus obtained has a red colour. This is *coagulated by heat*, and changed into a dirty slate colour. The addition of *liquor potassæ* dissolves the clot, and yields a solution, dark green by reflected, and red by transmitted light. The coagulum may be made to reappear by the addition of nitric acid. The blood solution has also the characteristic property of not being changed in colour by the addition of a small quantity of *liquor ammoniæ*. No other red solutions have these two characters. The red, pink, or scarlet infusions of flowers and roots, and the juices of fruits, are changed to green or violet by ammonia, and cochineal to crimson. The red solution of the *sulphocyanide of iron* yields with the same reagent a white precipitate of oxide of iron, and the pink solution of *permanganate of potash* is changed to blue.

Blood solutions yield a red precipitate to infusion or tincture of galls; but red colouring matters, due to the presence of salts of iron, yield a dark-blue precipitate.

Another test of considerable delicacy has been recommended by Sonnenschein.* A solution of *tungstate of sodium*, acidulated with acetic or phosphoric acid, gives, with solutions of the colouring matter of blood, a red precipitate which is soluble in ammonia, forming a dichroic, greenish-red fluid. This is again precipitated by acids. The precipitate, when fused with soda and a little nitre, leaves an insoluble residue of oxide of iron.

Ozonic, or Guaiacum, test.—Solutions of the colouring matter of the blood possess the property of transferring ozone from substances that contain it (peroxide of hydrogen, ozonic æther, or oil of turpentine) to ozone reagents, such as tincture of guaiacum, which become oxidized and changed in colour. If to a solution of the colouring matter of the blood a few drops of tincture of guaiacum are added, and then a few drops of solution of

* 'Vierteljahrsch. f. Gericht. Med.' 1872, xvii. 268-269.

'hydrogen, a rich, sapphire-blue colour results. This
ɪtly applicable to stains on linen, which, when moistened
ıre of guaiacum, and then with peroxide of hydrogen
ecome of a blue colour. This test is very delicate,
uite conclusive, as certain other substances seem also
› power of oxidizing guaiacum in a similar manner.
test.—Of all the tests for blood colouring matter this
; certain. But as there are certain conditions in which
ch failure must not be taken to prove the absence of
the test succeeds, it is absolutely conclusive of the pre-
›od. To apply this test, we must use the blood solution
to dryness, or a small portion of dried blood from a
e dried residue of the solution in a watch-glass, or a
dried blood on a microscope slide, is to be covered with
tic acid, a crystal of chloride of sodium added, and then
ıeated to boiling over a spirit-lamp. It is well to
addition of acetic acid once or twice, especially if the
conducted on a slide. On allowing the mass to cool,
n with the microscope will reveal, along with crystals
› and acetate of sodium,
numbers of dark-brown
ismatic crystals of hæmin,
33, in which (1) shows
stals after Virchow, and
: crystals from a minute
; of sheep's blood. They
in size according to the
'crystallization.

Fig. 33.

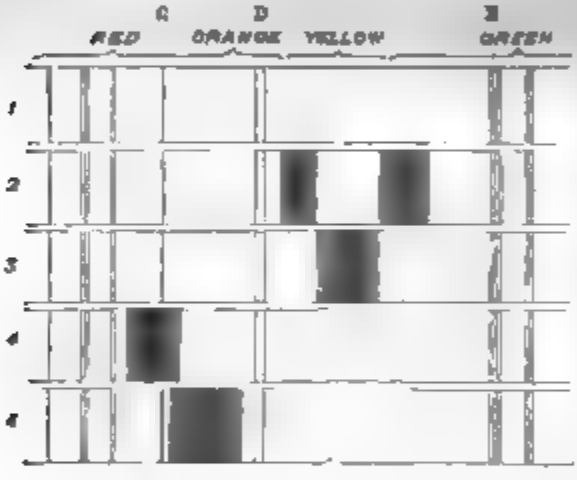
× 300 diameters. × 150.

ɪrystals are a compound of hydrochloric acid with
which is one of the products of the decomposition of
n. They are known as *Teichman's Crystals.*
tain has been dissolved in a solution of common salt (1
is unnecessary to add the chloride of sodium.
scopic test.—Solutions of the colouring matter of the
n examined through the spectroscope, give a spectrum
ed by the presence of definite absorption bands. If
n is too concentrated, only the red end of the spectrum
When of the proper degree of concentration, two dark
bands are seen in the spectrum in the green between
and E. The first absorption band—*i.e.*, from left, is nar-
more sharply defined than the second, which is sepa-
it by a green interspace. In very dilute solutions the
the first to disappear. The spectrum, with the two
bands, is that of oxidized hæmaglobin (2, fig. 34).

When a reducing agent is added to the solution, such as ammonium or sodium sulphide, the two bands disappear; and in their stead one band only is seen, dark in the middle, and with washed-out edges, occupying what was formerly the green interspace between the two bands of oxidized hæmaglobin. This is the spectrum of reduced hæmaglobin. (3. Fig. 34). By shaking the solution with air it is again reoxidized, and gives the spectrum with the two lines as before.

A red solution possessed of the above characters can only be a solution of blood colouring matter. Other red solutions, such as carmine and alkanet, give spectra, which, on careless inspection, might be mistaken for solutions of hæmaglobin, but their bands do not occupy exactly the same position in the spectrum, nor are they capable of reduction and reoxidation in the manner described. The reduction test should, therefore, always be had recourse to in determining by the spectroscope whether a given solution is a blood solution or not. Hæmaglobin, on the other hand, is liable to undergo decomposition spontaneously and under the influence of various reagents, and the spectrum undergoes corresponding alterations.

Fig. 34.



1. Solar Spectrum. 2. Oxidized Hæmaglobin. 3. Reduced hæmaglobin. 4. Hæmaglobin decomposed by acids. 5. Hæmaglobin decomposed by alkalies.

For a complete account of these various modifications reference should be made to Preyer's work on 'Die Blutcrystalle.' One of the most common alterations to be found in old stains is the formation of hæmatin, which gives a band in the orange or yellow according as the blood has been decomposed by acids or alkalies. If the whole of the hæmaglobin has been decomposed, only the one band of hæmatin is seen; but frequently a mixture of undecomposed hæmaglobin with hæmatin gives the conjoint bands of oxyhæmaglobin and hæmatin. The band of acid hæmatin coincides nearly with Frauenhofer's line c in the confines of the orange and red. (4. Fig. 34.) If the blood has been decomposed by

alkalies (soap, &c.), the hæmatin band is situated a little lower down the spectrum nearer the line D. (5. Fig. 34.)

In applying the spectroscopic test for blood, the ordinary spectroscope may be used if the quantity is comparatively large. The colouring power of hæmaglobin is very intense, 1 in 4500 of water giving the absorption bands in the ordinary spectroscope. If the quantity is very small—such as may be got from a small stain—the micro-spectroscope of Messrs. Sorby and Browning affords a very delicate method of manipulation. (Fig. 35.) It consists of an instrument which can be substituted for the eye-piece of the microscope; and contains the requisite prismatic arrangements for placing side by side a spectrum of the object on the stage, and (by the side slit) a second beam of light from any object whose spectrum it is desired to compare with that of the object placed on the stage of the microscope. By means of focussing arrangements, with which the apparatus is supplied, the light can be readily adjusted, and the spectra and absorption bands accurately defined.

Fig. 35.

By means of this instrument the spectrum of hæmoglobin may be obtained from a few blood corpuscles.

In very weak solutions of the colouring matter of the blood it is necessary to obtain a sufficient depth of colour before the absorption bands become visible. For this purpose the cells invented by Mr. Sorby are admirably adapted. One form of cell consists of a piece of barometer tubing about an inch in length, which is soldered on to a glass slide. By proper focussing and arrangement of the diaphragm, the light is made to traverse the whole column of the fluid, and in this way with a very weakly coloured solution a sufficient degree of concentration is obtained. The other form of cell is a wedge-shaped microscopical cell. When covered with a covering glass a wedge-shaped body of fluid is obtained, and the thick or thin edge placed in front of the objective as required. These cells also allow of the addition of reducing agents to the solution, and so all the spectroscopic reactions can be studied with excessively small quantities. As far as delicacy is concerned, the spectroscopic test for blood colouring matter exceeds all others.

Microscopical characters.—Blood is recognised under the microscope by the presence of the red (and white) corpuscles. The red corpuscles are highly characteristic. Their microscopic characters require to be minutely described, inasmuch as circular forms are very commonly met with, as in the oil-globules of milk, the spores of yeast, and many crystalloids, organic and inorganic. The appearance of the globules in mammalia is shown in plan and section, largely magnified, in the annexed figure, after Gulliver. They have also been depicted in plan as a circular disk with shaded centre, in section as a bi-concave lens. But their appearance differs with the power of the microscope, the light, and the focus. A quarter-inch object-glass is as high a power as it is necessary, or perhaps desirable, to use; and they can be well seen with a good half-inch. When viewed by transmitted light, they appear, when out of focus, as convex disks with faint outline; as we approach the true focus, the outline becomes dark and distinct; and when quite in focus, they seem to have a dark inner margin, a slight shaded depression, or a dark central shadow. Similar changes take place when the mirror is slowly moved, so as to place the object under a succession of brighter and dimmer lights. The observer should provide himself with a standard specimen of human blood globules with which to compare, for form and size, that which happens to be under investigation. The figure annexed shows the blood corpuscles as isolated disks (*a*) in plan; (*b*) in profile; (*c*) aggregated like piles of coin; (*d*) variously contracted and crimped by the exudation of their contents. The white corpuscles are fewer in number, but somewhat larger in size. They have a granular aspect and contain one or more nuclei.

Fig. 36.

Fig. 37.

Magnified 400 diameters.

Examination of Blood Stains.—Blood stains on linen:—Before applying the tests, note should be made of the article of dress, and the position and the number of the stains. It is well to note whether the stain is on the inside or outside of the garment, and whether one or more articles of dress are stained in a corresponding part. Blood stains have certain characters recognisable *without* any extraneous aids. A spot of blood not disturbed by contact or friction feels like thick gum or starch. Small spots

are circular, large spots approach the circular form; large and small alike have a defined and abrupt margin.

Arterial blood has a bright red colour, and venous blood a dark or purple hue, but becomes arterial on exposure to the air. After the lapse of a few hours both kinds of blood lose their bright colour and assume a reddish-brown hue, which may remain unchanged for years.

Certain of the above-mentioned tests are at once applicable to the stains, and they may be applied before proceeding to the others. A small stain or a minute fragment of a stain, if only one exists, may be cut out and tested first with *liquor ammoniæ*. This will at once distinguish between blood and vegetable colouring matters. To a similar fragment (a few fibres will do) a drop of tincture of guaiacum and a drop of peroxide of hydrogen should be added on a slide. If blood colouring matter is present the result will be the production of a sapphire blue colour. If the stain is very old* and dry this reaction does not take place at once, and not until the texture has become thoroughly moistened. The other tests, with the exception of the hæmin test, require the solution of the colouring matter. The hæmin test is perhaps more conveniently applied before the solution is made. For this purpose a small scraping of the stain is to be laid on a slide, a crystal of chloride of sodium added, and then boiled with glacial acetic acid in the manner before described. As already stated, the demonstration of hæmin crystals is proof positive of the existence of blood. The solution of the stain is best made in a solution of common salt (1 in 200). The stain is to be cut out and suspended by a thread in a test tube or watch-glass containing a small quantity of the salt solution. A recent stain so treated, generally yields a reddish or reddish-brown solution, the colour being most intense in the deeper strata. If the stain is old, it gives up its colour very slowly and imperfectly, the process taking many hours. The solution may be aided by tearing the fibres of the cloth and by agitation.

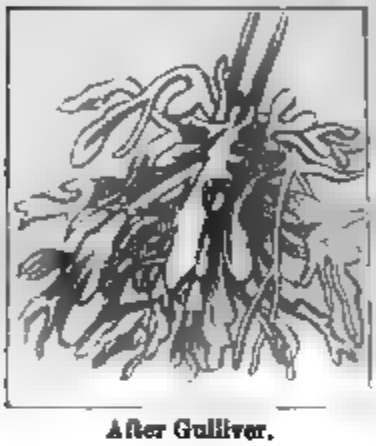
When the solution has been effected, the cloth may be examined with a lens for the presence of threads of insoluble fibrin which remain after the colouring matter has been entirely dissolved. (See fig. 38.)

When the solution has been allowed to settle, the superficial

* *Age of the spots or stains.*—Dr. Plaff has suggested a solution of arsenious acid (gr. ½ to ℥j) as a blood-solvent and means of ascertaining the age of a stain. He thought that he could fix the age by the quicker or slower solution of the colouring matter. His own loose statements as to the time required sufficiently condemn his not very promising proposal.

layer of fluid may be drawn off with a pipette, and the deep layer examined for blood corpuscles. These are quite characteristic if obtained, but in old stains they are frequently not to be found, as they have become disorganized. Occasionally the white corpuscles may be seen when the red have all disappeared. Care must be taken not to confound torula cells with blood corpuscles. These torula cells are frequently to be met with in old blood stains.

Fig 38.



After Gulliver.

After the microscopical examination the solution should be submitted to the spectroscope. The micro-spectroscope enables us to determine the presence of the absorption bands and the reducibility of the solution with excessively small quantities.

The other chemical tests for blood already mentioned may then be applied if necessary to small quantities of the coloured solution.

By the above tests, singly or in combination, blood stains can, as a rule, be readily identified.

Iron moulds on linen have, as in a case related by Devergie, been mistaken for spots of blood; but the distinction is easy. Cold water dissolves the colouring matter of blood more or less completely, but it does not affect the iron mould. Hydrochloric acid dissolves out the iron mould, which may be recognised by its appropriate tests.

Blood Stains on Floors, Furniture, &c.—Frequently walls or pieces of furniture are spotted with blood. The shape of the stain is often of great importance to note. If blood has spouted from an artery on to a wall it forms a stain resembling in shape a large "point of exclamation" owing to the subsidence of the fluid to the lower end and its coagulation there. The direction of the spot and its degree of obliquity may indicate the position of the wounded vessel. It is possible that a stain similar to that of an arterial jet may be caused by splashing of blood on to the walls or furniture.

Blood-stains on carpets, &c., may often be detected by bringing a lighted candle to bear on the surface. At the proper angle of incidence the blood-stain may be recognised by its shiny surface. A scratch with the nail causes on it a vermilion streak. The

stains can be examined in the manner above described for stains on linen.

The wood may be shaved off and immersed in water or salt solution, or the stain may be scraped, and the solution made. If the stains are on articles which cannot be immersed, cut, or scraped, a solution may be obtained by placing on the stain moistened filtering paper. This absorbs the colouring matter, and may be used for testing. In applying the guaiacum test to blood colouring matter on filtering paper, it is well to bear in mind that some specimens of Swedish filtering paper cause of themselves the ozonic reaction without the presence of blood colouring matter.

Blood-stains on articles of steel and iron are readily identified when they present themselves in the form of clots on a clean bright surface of metal. They are then of a clear red, or reddish-brown colour, are easily detached, and scale off on exposure to a moderate heat. The presence of animal matter in the spots is readily ascertained by heating them in a reduction-tube. Ammonia is given off, and identified by its alkaline reaction on turmeric paper. A small particle of blood-crust is sufficient for this purpose. The crust placed in a few drops of distilled water will, after a time, yield a reddish-brown solution with the reactions already described; and if treated with syrup or glycerine, and placed under the microscope, will be found to contain blood-globules.

If the blood is merely smeared upon the instrument it will not scale off when heated; but it will be necessary to moisten the stain with distilled water, and scrape it off carefully for examination by tests or the microscope.

If the instrument has been for some time exposed to air and moisture, spots of rust will be mixed with those of blood. In this case, too, the stains are not detached by heat, and it will be necessary to scrape them off, place them in distilled water, and separate the insoluble particles of rust by filtration. The resulting coloured liquid will have the chemical and microscopic characters of the blood solution.

Two other kinds of spots on articles of steel or iron have been pointed out as liable to be mistaken for spots of blood—namely, spots of rust, and spots produced by lemon-juice, vinegar, or other vegetable acid.

Spots of rust somewhat resemble blood-spots in colour, but they do not scale off, and are not soluble in water. If thick enough to be detached, they are readily separated by filtration, leaving the water quite clear, and not affected by the tests for

iron. A drop of hydrochloric acid placed on the spot of rust dissolves it, and leaves the metal clean, and on diluting the solution with distilled water, evidence of the existence of iron may be obtained by appropriate tests.

Spots of lemon-juice have been mistaken for those of blood. A man, as in a case related by Orfila, was suspected of having murdered another, and a knife, apparently covered with blood, was found in his possession; but on examining the knife, the spots were found to be due to citric acid. The instrument had been used some days before for cutting a lemon, and had been put by without being wiped.

The thinner spots produced in this way have a reddish-yellow, the thicker a reddish-brown, colour, nearly resembling that of blood, and they separate, like blood-spots, when moderately heated. When heated in a tube they give off a volatile matter, which has an *acid* reaction—spots of blood have an *alkaline* reaction. The solution in distilled water is *light yellow*—that of blood is *red*; it sometimes has an *acid* reaction—that of blood is *neutral*, or *faintly alkaline*; with infusion of galls it yields a *black* precipitate, a *blue* with ferrocyanate of potash, and a rich cherry red with the sulphocyanide of potassium. Blood yields a *red* precipitate with the first test, and is unaffected by the others. The oxide of iron is thrown down by alkalies.

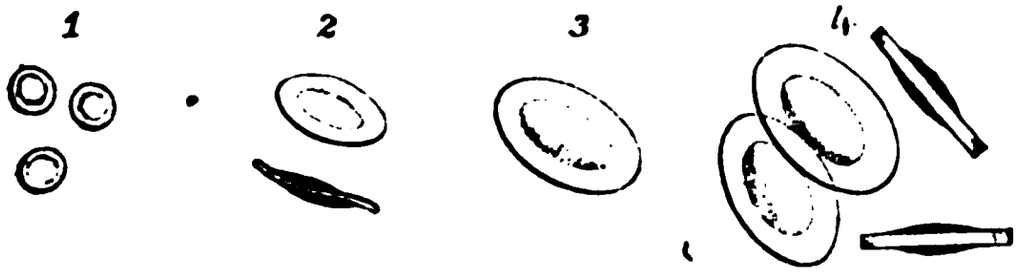
It having been clearly made out that the stain we have been examining is a blood-stain, three questions may arise: 1. *Is it human blood, or that of an animal?* 2. *From what part of the body did it flow?* 3. *What is the age of the stain?*

1. *Human blood and that of animals.*—Two means of diagnosis have been proposed, the one microscopic, the other chemical.

Diagnosis by the microscope.—The only means of distinction under the microscope is afforded by certain well-known differences in the shape and size of the corpuscles. The human blood-corpuscle, depicted in fig. 36, p. 326, is a circular flattened disc; and that of mammals, with a single unimportant exception, has the same form. The only appreciable difference is in the size of the globules. In man they measure on an average $\frac{1}{3200}$ of an inch; in animals the diameters vary from $\frac{1}{3240}$ to $\frac{1}{3333}$. But these are only averages; and the extreme measurements which in man may be stated at $\frac{1}{3000}$ and $\frac{1}{4000}$, lie, in some animals, still wider apart. When it is borne in mind that, in most instances, we have to examine a blood-solution obtained from dried blood, made to approximate to the average density of blood by the addition of syrup, glycerine, or a saline solution; that the size of the globules is materially affected by the density of the

medium in which they float; and that in the blood itself the diameter of one globule may be twice as great as that of another, it is not to be expected that the most skilful and practised person should be able to distinguish human blood from that of other mammals. But the blood-corpuscles of birds, reptiles, and fishes differ so widely in size and shape from those of man and animals, as to enable us to state positively that the blood in a given case is either that of a mammal, or belongs to one of the three classes of creatures just specified. The differences of size and shape are shown in the annexed woodcut, in which (1) is human

Fig. 39.



× 400 diameters.

blood, (2) the blood of the common fowl, (3) the blood of the frog, and (4) the blood of a fish. (For some minute details of measurements in Mammalia, see 'Micrographic Dictionary,' Art. Blood, as well as Plate 39.)

Chemical Diagnosis.—It was Barruel who first proposed to distinguish the blood of different animals by the characteristic odour given off on adding sulphuric acid. If this acid, diluted with half its bulk of water, is added to the blood of an animal, an odour is perceived which closely resembles that of its perspiration; and probably persons would recognise the odour if informed of its existence, and equally probable that they would be mistaken if asked to name the animal which had supplied the blood.

I make this statement as the result of experiments with fresh blood of different animals, in such quantity as a drachm or more, made in the class-room for several years in succession. The majority have always been wrong in their guesses; but on one occasion, a member of my class was uniformly right in his opinion, though the experiment was so devised as to preclude mere guessing. As a means of distinguishing spots of blood, or solutions obtained from them, this test must certainly be disallowed. It has utterly failed in the hands of very competent persons. (G.)

In 1844, Professor Taddeï published at Florence a treatise, in which he proposed to distinguish the blood of man from that of other creatures by a method as remarkable for its minute complication as for its eminently uncertain results. Briand and

Chandé, in their 'Manuel' (7th edition, p. 748), describe the method at length, and present us with a tabular arrangement for the mammalia which sufficiently justifies this short notice of it. In this table the blood of carnivorous animals (cat, fox, and dog), and of the mouse, are grouped with that of man as *très fluidifiable*, while the majority of our domestic animals are grouped as *médiocrement fluidifiable*, and a small group of ruminants as *non-fluidifiable!*

2. It has already been stated (p. 52) that we possess no means of distinguishing menstrual blood from blood from a wound, further than that the position of the blood on the dress, and the nature of the dress, along with the occurrence of epithelial scales (squamous and cylindrical), may help us in drawing a conclusion as to its menstrual origin.

In some cases the spots submitted for examination are found blended with hair, skin, or mucous membrane, or with other matters adhering to the material on which the blood has fallen. The discovery of such admixtures may often supply very important medico-legal information.

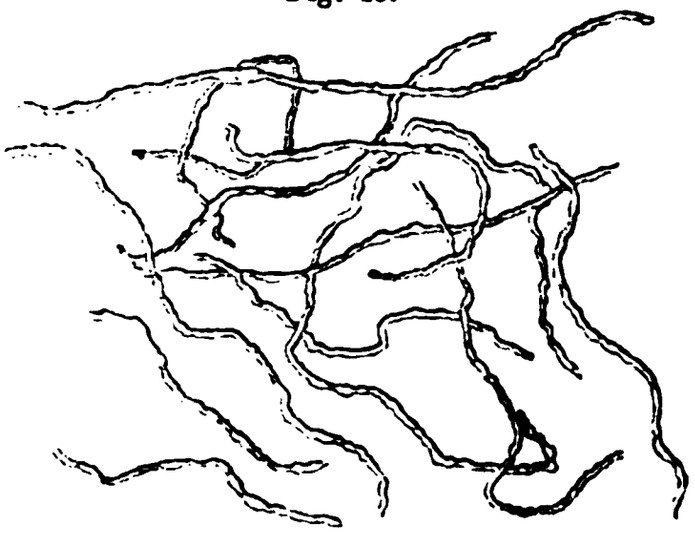
Hairs on Weapons.—Weapons which have inflicted wounds are generally blood-stained, and frequently adhering to the blood-clots, or otherwise entangled in the weapon, we may discover hairs, and it is very important as to the source of the blood, whether the hairs in question are human hairs or not, and whether they correspond to the hairs on the body of the person who has been wounded. For this purpose a careful comparison of the hairs found with those on the body of the deceased is necessary. Hairs must not be confounded with fibres of cotton, linen, wool, or silk. Fibres of cotton have a twisted appearance, those of linen have a tapering jointed structure, those of silk are smooth, and those of wool have a peculiar spiral-like imbrication. (Fig. 41.)

Hair consists of a cortical and medullary substance, and is covered by an imbricated cuticle. When the hair is young and soft the medullary portion may be absent, and the whole hair has a fibrous appearance. The dark, irregular appearance of the medulla, the striated cortical substance, and the peculiar imbrication of the cuticular scales, render hair easily recognisable. The hairs of the head are usually truncated or split at the free end, while those of the body are, as a rule, pointed. Occasionally we may be able to determine the origin of the hair in this manner. The hair of the lower animals differs from the human hair in several respects. Frequently the hair is entirely cellular, at other times there is a combination of the cellular with the

fibrous structure. Examples of both kinds are given in the accompanying woodcuts (p. 334), which may serve as standards of comparison both as to appearance and relative size.

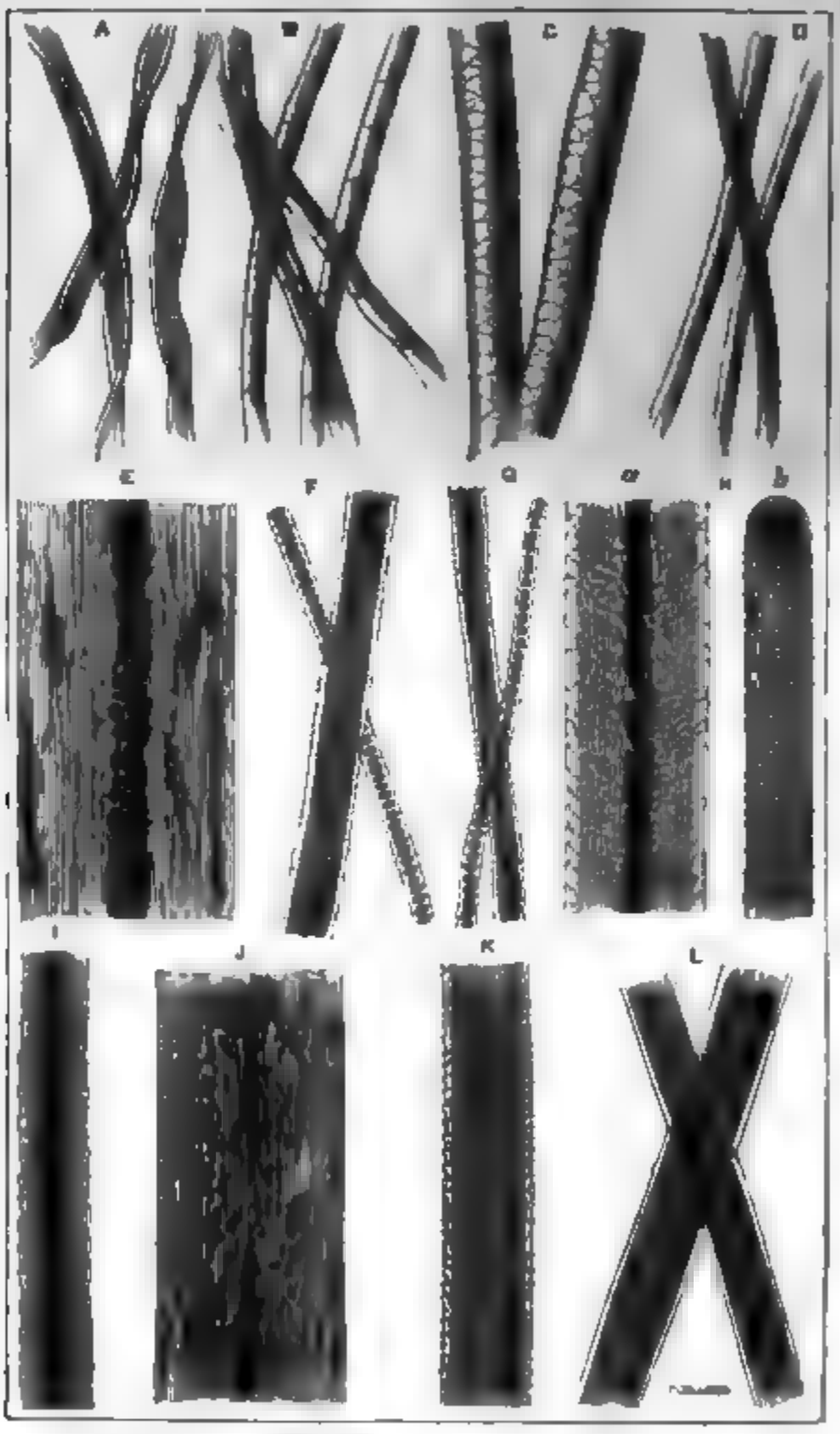
Brain Substance on Weapons.—Occasionally on weapons which have caused fracture of the skull and laceration of the brain, portions of brain-substance may be found. When fresh, it will not be easily mistaken. When dry, the brain-matter becomes grey or brown, and horny. When moistened, it becomes of a whiter colour, and a soapy consistence. Attempts have been made to recognise brain-substance by its reaction with sulphuric and hydrochloric acids; but they are not satisfactory, and may mislead. The only satisfactory method of detection is by means of the microscope. When the matter is softened in distilled water or in salt solution, the evidence will be found of the presence of nerve cells or of nerve fibres. These are small ($\frac{1}{5000}$ inch or less in diameter), generally ampullated (Fig. 40), or they may have been disorganized, and only myelin drops may remain.

Fig. 40.



3. A spot or stain of blood, once formed, soon puts on the colour which it continues to retain for a long term of years. It is only in the case of spots on iron or steel exposed to air and moisture that any notable change occurs: and this is not such a change as enables us to fix the age of the stain. Such attempts as that referred to in the note to p. 327 must needs fail.

Fig. 81.



A. Fibres of Cotton. B. of Linen. C. of Wool. D. of Silk.
E. Hair of Pig. F. of Rabbit. G. of Hare. I. of Horse. J of Cow. K. of Cat. L. of Dog.
H. Human hair. From head (a); from body (b).

CHAPTER IV.

DEATH BY FIRE—SPONTANEOUS COMBUSTION—DEATH BY LIGHTNING—BY COLD—BY STARVATION.

DEATH BY FIRE.

On the average of the five years 1852-56, 2623 deaths in England and Wales were attributed to the agency of heat. Of this number 483 were burns, of which 436 were by clothes catching fire, 15 by conflagrations, 24 by gunpowder and fireworks, and 7 by explosive gases. 46 deaths were caused by drinking hot water; and 541 deaths by scalding liquids, entered under "Burns and Scalds." 1548 deaths were less accurately defined. In the whole five years, 2 suicides, 1 murder, and 4 manslaughters were attributed to burning, and 2 manslaughters to scalds. In 1871, the deaths by burns and scalds were 2612.

The cause of death by burning is not always the same. Some are suffocated by smoke; others die frightened, or by blows from falling bodies; others by the shock that follows extensive injury to the tissues; and others, again, at periods more or less remote from the burning, by collapse, or the effects of inflammation.

The appearances produced by burning consist of blisters, entire or burst, roasted patches, sooty spots and marks from burnt articles of clothing, and singed hair.

The medico-legal questions that arise in reference to death by fire are those relating to other forms of external injury, except that the alternatives of suicide and homicide rarely present themselves; for most deaths by fire are accidental. In these, and in the rare cases of suicide and murder, the burning would leave marks on the body showing that it was inflicted during life; but as the burning of the dead body is sometimes resorted to by a murderer to conceal the real mode and cause of death, we may have to distinguish burns taking place during life from those occurring after death. Again, when a body is found with marks of burning too

extensive to be readily accounted for by the quantity of fuel consumed, it may become a question whether it was unusually combustible or had undergone a process of "spontaneous combustion."

Burns inflicted during life and after death.—We owe our knowledge of this subject mainly to experiments made by Christison, Casper, Champouillon, and Chambert. The last-named author exhausted the subject by the number and accuracy of his experiments; and we shall therefore adopt his conclusions, with modifications suggested by the more certain of the results of the earlier writers.

Burns in the living body caused by substances which do not char and destroy the tissues, produce two characteristic appearances—redness and vesication. The redness (more or less intense as the heat is greater or less, and the time of its application longer or shorter), described by Casper as "crab-red," affects both the surface and substance of the true skin, which is dotted by the deep red openings of sudoriferous and sebaceous ducts; and it also extends to the subcutaneous tissues. Sometimes the colour is a brownish red, and the skin dry and parchment-like. Blisters, more or less numerous and extensive, also make their appearance at a temperature below that of boiling water, and contain serum, which either coagulates in mass, or yields an enormous precipitate of albumen when heated, or tested with nitric acid. The albumen is more abundant when wholly due to vital action than when the burn, being inflicted at the point of death, the vesicle forms after life is extinct. These appearances belong equally to burns made at the point of death and to those made twenty hours previously. But vesicles are sometimes absent in burns whatever the period at which they were inflicted.

On the other hand, in post-mortem burns, the surface and substance of the true skin are a dull white, dotted with gray at the openings of the sudoriferous and sebaceous ducts; and the subcutaneous tissues are uninjected. No vesicles are produced by a temperature below 212° Fahr.; and those caused by a higher temperature either contain no fluid, or one which, containing little albumen, merely becomes opaline or milky when treated by heat or nitric acid. Post-mortem vesicles are most readily produced in anasarcous subjects.

The appearances caused by burns inflicted during life, show themselves in all healthy, and in most sick subjects; but the case of a consumptive patient, reported by M. Bouchut, shows that the application of heat to the skin of a dying man may produce as little effect upon it as upon a corpse.*

* This case is quoted by Chambert in an elaborate paper in the 'Annales d'Hygiène,' April, 1860, to which the reader is referred.

Casper sums up the results of very numerous experiments by stating that "vesications can be produced on the dead body," and "that it is quite impossible to confound a burn inflicted during life with one inflicted after death." He also alleges that "every vesication produced by burning" during life "has a purple-red boundary line, be it ever so narrow, perfectly visible to the naked eye, and also a more or less red base." Vesicles caused by putrefaction are readily distinguished by the absence of these appearances, the exposed true skin being, like that of adjacent parts, colourless or green.

The appearances just described as due to the application of heat to the living body are common to all intense inflammations of the skin, whether due to disease, or produced by the application of cantharides and other strong stimulants, by pressure, or by friction. I have seen, on the ankles of a young man who had died of acute phthisis, two patches of inflammation of a deep red colour not removable by pressure, and with well-defined margins, on one of which were large vesicles containing serum. I ascertained beyond doubt that the spots, which had been observed during life, were not caused by the application of any heated body. (G.)

In all these cases of acute cutaneous inflammation, a thin vertical section of the inflamed skin and underlying tissues displays, even to the naked eye, distinct red patches, contrasting very strikingly with similar sections of skin discoloured by the mere subsidence of the blood.

It is scarcely necessary to add that redness follows instantly on the application of heat, and that vesicles show themselves after the interval of a few seconds. The results just stated have a direct bearing on those rare cases in which, as in that of Bolam, tried at Newcastle in 1839, arson is resorted to to conceal the true cause of death. Of the question of *accident*, *suicide*, or *homicide*, it must suffice to observe that suicides and homicides by fire are of very rare occurrence, the great majority of cases being accidental. The suicidal cases occur chiefly among persons of unsound mind.

SPONTANEOUS COMBUSTION.

The following case, which rests on the authority of Le Cat, a firm believer in spontaneous combustion, forms a fitting introduction to this subject. It is said to have taken place in 1725:—

One Millet, of Rheims, was charged with the murder of his wife, the remains of whose body were found lying near the

kitchen hearth. Part of the head, portions of the lower extremities, and a few of the vertebræ, had escaped combustion. The floor beneath the body was partially burnt. Millet stated that he and his wife had retired to rest the previous evening,—that she, not being able to sleep, got up and went into the kitchen, as he supposed to warm herself; that he was roused by the smell of fire, and going down to the kitchen, found the deceased lying near the hearth, in the manner stated. The prisoner was condemned to death, but, on appeal to a higher court, the sentence was revoked, and it was pronounced to have been a case of spontaneous human combustion.

In this case the extent to which the body was consumed gave some support to the opinion, that it was more combustible than human bodies in general, but no countenance to the notion that the fire originated in the body itself. It was certainly in the most favourable circumstances for being *set on fire*, and thus is true of most of the cases of alleged spontaneous combustion reported to have occurred in England and abroad.

Orfila testifies his belief in spontaneous human combustion by thus describing the phenomena that accompany it:—A light blue flame appears over the part about to be attacked: this flame is not readily extinguished by water, which indeed frequently serves to increase it. Deep eschars now form in the part affected, accompanied by convulsions, delirium, vomiting, and diarrhœa, followed by a peculiar state of putrefaction, and death. The process is said to be extremely rapid, but the body is never entirely consumed: some parts are only half burnt, while others are reduced to a carbonaceous, fœtid, unctuous ash. The hands and feet commonly escape destruction, while the trunk is usually entirely consumed. The clothes covering the body are commonly destroyed; but articles of furniture standing near commonly escape. The walls and furniture are covered with a thick greasy soot, and the air is impregnated with an offensive empyreumatic odour. The phenomenon is stated to have been observed chiefly in aged corpulent females, and especially in persons long addicted to the abuse of spirituous liquors.

It is practically of little consequence whether the doctrine of *spontaneous* combustion be true or false. The cases on record (Jacobs, as cited by Casper, has brought together 28, of which 20 occurred in France) create a presumption in favour of an unusual combustibility of the body, occurring in rare instances and for the most part, in corpulent spirit-drinking females, merely requiring to be set on fire, and needing no other fuel but their clothes, night-dress, or ordinary bed-furniture. Till we possess

cases better authenticated, and more accurately reported, we must content ourselves with this amount of knowledge, not forgetting, meanwhile, that such men as Liebig and Casper treat the very notion of spontaneous combustion as an idle fable, stamped with the brand of sheer credulity, and one opposed to such simple facts, among others, as that the human body contains 75 per cent. of water.

The spontaneous combustion of inorganic substances, a subject of much interest and importance, has no medico-legal bearing.

DEATH BY LIGHTNING.

From the Reports of the Registrar-General for the five years 1852-56, we learn that about 21 deaths by lightning occur, one year with another, in England and Wales; 18 in males and 3 in females. This mode of death rarely gives rise to medico-legal questions; but as the effects of lightning on the body often resemble those caused by mechanical violence, a question might arise, whether a person found dead, under unknown circumstances, had perished by lightning or had been murdered.

In most cases we have a clue to the cause of death in the fact that a thunder-storm has taken place, and that the corpse is found in such a situation, and with such surroundings, as is consistent with its having been struck by lightning.

As a general rule it may be stated, that the electric fluid prefers and seeks out good conductors; and as the human body is a very good conductor, it is as likely to be struck as any object similarly situated, unless, perhaps, that object be of metal.

As a general rule, too, lofty objects are the most likely to be struck; but this rule is subject to many exceptions, for persons have been struck in the immediate neighbourhood of lofty trees which have been uninjured; and in woods it is not always the tallest trees that are struck.

The electric fluid is often conducted to the body by lofty objects in its proximity, such as trees, masts, the rigging of ships, and the moist strings of kites. The danger of remaining under a tree during a storm is proverbial.

It has been thought that a person is tolerably safe in an open space far from any object which could attract the electric fluid; but this is an error. The human body may be, in these circumstances, the most prominent object and also the best conductor.

Death may be caused by an electric shock, other than the lightning stroke. This happens when a cloud near the earth is negatively electrified, while the earth is positive, and the human

body serves as the conductor, by which the equilibrium is restored. This is called the *ascending or returning stroke*.

The violent mechanical effects produced by the electric discharge —the disruption of buildings and removal of parts of them to a distance; the rending of the trunks of trees into laths; the separation of good conductors from bad ones; the fusion of metallic substances; the ignition of inflammable ones; the magnetic properties communicated to articles of iron and steel—are familiarly known.

The *Post-mortem appearances* in bodies struck by lightning are very various. Sometimes no marks of injury are found, and this is said to occur most commonly in death by the *returning stroke*. In other cases the body is bruised or torn at the spot where the electric fluid has entered; or there is merely a small round hole at the point of exit. Extensive bruises are sometimes present, most frequently on the back, the electric fluid appearing to prefer the track of the spinal cord. Fractures of the bones are rare: they may occur, as Ambrose Paré states, without external wound. A case of extensive fracture of the bones of the skull is related by Pouillet. Marks of burns are sometimes present. They may occur even when the clothes have not been set on fire.

The state of the blood (alleged by some authorities to be fluid, by others coagulated), the state of the limbs (asserted by some to be relaxed, but by others, with better reason, to be rigid, and sometimes even to become quickly and excessively so), and the putrefactive process (stated by Paré and others to be retarded, but by others to be hastened)—are signs of little medico-legal importance. These points are worthy of note; but even should the blood be fluid, rigidity absent, and putrefaction hastened, these are not peculiar to death by lightning, for they may all coincide in other modes of sudden death.

In some cases the state of the objects found on the corpse, or belonging to it, furnish complete evidence of the cause of death. The clothes may be torn and burnt; the shoes struck from the feet; metallic bodies fused and forcibly carried to a distance; and articles of iron or steel, such as the steel of the stays, or the main-spring of a watch, rendered strongly magnetic.*

Cause of Death.—The electric fluid acts chiefly through the nervous system, and the cause of death is the shock sustained by it. When not fatal, its action on the brain, spinal marrow, or

* A full description of the effects of lightning will be found in Dr. Bistiar's work 'De la Foudre.' Paris, 1856.

nerves, is shown by loss of sight, sensation, or voluntary motion, temporary or permanent.

DEATH FROM COLD.

This is an uncommon event in this country, though death by cold and inanition combined is not very rare in severe winters.

The first effect of intense cold is a sense of numbness and stiffness in the muscles of the limbs and face. This is soon followed by torpor and profound sleep, passing into coma and death.

The effect of cold on the circulation is to drive the blood from the surface to the interior of the body, so as to gorge the spleen, liver, lungs, and brain. The genital organs are similarly affected, and priapism sometimes results from congestion of the penis. The temperature of the blood itself is lowered; the heart contracts slowly and feebly, causing a small, weak pulse. The congestion of the nervous centres occasions numbness, torpor, somnolency, giddiness, dimness of sight, tetanus, and paralysis; and the congestion of the brain sometimes occasions a species of delirium, as happened to Edward Jenner, or the appearance of intoxication, as witnessed by Captain Parry and others in the expeditions to the North Pole.

The effect of cold varies in intensity with sex, age, and strength: the very young, the aged, the infirm, persons worn out by disease and fatigue, and those addicted to the use of intoxicating liquors, perish soonest. Some persons, too, have a great advantage over others in their power of resisting cold—a fact frequently observed by voyagers and travellers in the Arctic regions.

In estimating the effect of cold on the body, it should be borne in mind that the body is cooled in three ways—by cutaneous exhalation; by conduction of the air in contact with it; and by radiation.

The *cutaneous exhalation* is increased by dry and diminished by moist air. Hence the body parts with its heat more rapidly in a dry atmosphere. On the other hand, the body is cooled by *conduction*, when the air is moist; so that the body is cooled alike by dry cold air and by cold moist air. Cold humid winds lower the temperature of the body in a very striking degree. A rapid renewal of the air, as in a brisk cold wind, lowers the temperature of the body, both by evaporation and by conduction. The effect of a slight breeze in increasing the feeling of cold was remarkably shown in the expeditions to the polar seas.

Post-mortem Appearances.—As a rule, the surface is pale, but, in exceptional cases, florid. The viscera of the head, chest, and abdomen are congested. There is congestion of the vessels of the

brain, but extravasation does not appear to have been noticed, though death was formerly attributed to apoplexy. In two cases reported by Dr. Kellie, of Leith, there was a large effusion of serum in the ventricles of the brain. The blood in the aorta and left cavities of the heart is stated by Dr. Paris, on the authority of Sir B. Brodie, to be florid. These appearances are not so characteristic as to be conclusive of the cause of death.

The question of accident, suicide, or homicide rarely finds place in this mode of death; but, in one singular and horrible case, death by cold was a homicidal act. A girl, 11 years of age, a few years since, was compelled by her parents to stand naked in a pail of ice-cold water, while the water was being poured over her till she died.

DEATH FROM STARVATION.

This is a very rare event; but death from cold in persons insufficiently nourished is not infrequent. Cases of homicide by the deprivation of food, are of occasional occurrence; the insane sometimes commit suicide by obstinately refusing to take sustenance; some prisoners under long sentences would starve themselves if not fed by force.

The Symptoms produced by protracted Abstinence are pain in the epigastrium, relieved by pressure, with intense thirst, and extreme weakness and emaciation. The face is pale and ghastly; the cheeks are sunken; the bones project, the eyes are hollow, wild, and glistening, the breath hot; the mouth dry and parched. The body at length exhales a fœtid odour, the mucous membranes of the outlets become red and inflamed, and death takes place in a fit of maniacal delirium, or in horrible convulsions.

From Willan's case, presently to be cited, and the statements of prisoners who have voluntarily abstained, it appears that the craving for food disappears in about three days, and that the second day of abstinence is that of greatest suffering. (G.)

Post-mortem Appearances.—The body is much emaciated, and exhales a fœtid odour; the eyes are red and open, the skin, mouth and fauces dry, the stomach and intestines empty and contracted; the gall-bladder is distended with bile; the heart, lungs, and large vessels are collapsed, and destitute of blood; and putrefaction runs a rapid course. These appearances are not so characteristic as to be decisive of the mode of death; but in the absence of any disease productive of extreme emaciation, such a state of body will furnish a strong presumption of death by starvation. It must be recollected, that there are maladies such as

stricture of the œsophagus, and organic disease of the stomach, which prove fatal by starvation. Search should, therefore, be made for such causes of death.

The post-mortem appearances were faithfully described by Mr. Biggs in a case of murder by starvation and exposure; that of Mark Cornish, starved by his father and step-mother.* He stated at the coroner's inquest that the deceased was so wasted that he had scarcely any muscle left, and no fat; that he looked like a skeleton with the skin tightly stretched over him; that he could not only see each bone but its peculiarities; that all the organs were healthy, though the heart and stomach were small; that the *omentum* was as clear as glass; that there was no food in the stomach, and that the small intestines were nearly empty; and that there was no appearance of chyle.

The period at which death happens varies with age, sex, and strength, the amount of exertion, and especially with the supply of water.

The time that a person may remain without food, or with a very scanty supply of it, may become a question of some importance, as will appear from the case of Elizabeth Canning, quoted by Dr. Cumming in his Lectures in the 'Medical Gazette,' vol. xix. The question raised in this case was, whether a girl of eighteen could be confined, in the depth of winter, twenty-eight days, without fire, with about a gallon of water in a pitcher, and with no food but some pieces of bread, amounting altogether to about a quartern loaf, and a small mince pie which she happened to have in her pocket, and at the expiration of the period retain sufficient strength to break down a window-shutter fastened with nails, get out of the window on to a sort of pent-house, thence jump to the ground, nine or ten feet below; and finish by walking from Enfield Wash to Aldermanbury.

To this question we could not but return an answer in the negative. The cases presently to be cited give us good ground for believing, that life might have been prolonged for twenty-eight days, or even more, on this scanty supply of nourishment; but it is extremely improbable that, at the end of this time, Elizabeth Canning would have had strength enough left to effect her escape. This case is also curious in its bearing on the question of identity. A fresh interest has been given to this question of prolonged abstinence from food by the case of Sarah Jacob, the Welsh fasting girl.

There are four distinct classes of cases which may be used to

* 'Morning Chronicle,' February, 26, 1853.

throw light on the question of the duration of life possible under complete, or nearly complete deprivation of food. 1. Cases of mechanical obstruction to the passage of food through the gullet. 2. Cases of shipwrecked persons subject to exposure and fatigue. 3. Cases of persons imprisoned, and rendered inactive, by such obstructions as falling earth in mines. 4. Cases of persons abstaining from food of their own accord, generally under circumstances demanding little exertion of mind or body.

1. For an interesting case of this class we are indebted to Dr. Currie, of Liverpool. A man, 66 years of age, survived a complete obstruction of the gullet (with the aid of nutritious clysters and baths of milk-and-water administered during 32 days) for 36 days. The man, who was tall and corpulent, was reduced from an ascertained weight of 240 lbs. down to 138 lbs.—a loss of 102 lbs., of which two-fifths took place in the space of 32 days, for his weight before the complete obstruction of the gullet was 179 lbs. In the last twelve days he lost 16 lbs., or at the rate of 1⅓ lb. per diem; and this loss the already wasted frame sustained in spite of the nourishment administered in the mode just described. What the unchecked rate of waste would have been we have no means of ascertaining; but we know that death took place when the body had lost 102 lbs. out of 240, or little more than two parts in five of its original weight. Now this reduction of two-fifths corresponds most closely to the results of Chossat's experiments on animals. He laid it down as a broad principle derived from experiments on many different living creatures that life ceases when an animal loses two-fifths of its weight. So that an animal weighing 100 lbs. would die when its weight was reduced to 60 lbs. Though life may cease before this point is attained, it can rarely extend beyond it. The time during which the destructive change is going on may vary greatly in different classes of animals, but the limit is the same in all. The daily loss amounts to one-twenty-fourth of the entire weight:—a statement in harmony with the conclusion of Bidder and Schmidt, that an animal, to maintain its weight, ought to take one-twenty-third part of it daily, in the shape of food susceptible of being assimilated, water of course included. But, if we assume a man to weigh 230 lbs., the daily supply will reach the most unlikely quantity of 10 lbs.

The progressive and rapid waste of the body, and the extinction of life at or about the point at which an animal loses two-fifths of its weight, may therefore be taken as data sufficiently established, as also the fact, long since established by Redi, that

animals live much longer (birds more than twice as long) when they have free access to water.

2. Of the prolongation of life under the fatigues, exposure, total privation of food, and want of fresh water (except such as may have been supplied by dew or rain) incidental to shipwrecks, we have some well authenticated cases. A narrative of a shipwreck on the Calcutta coast which has been placed at my disposal shows that out of 13 men without food or water 12 days, three died, the rest escaped and recovered. (G.) And a very detailed and evidently faithful account of the picking up at sea of Captain Casey, Commander of the *Jane Lowden*, timber vessel, shows that out of 18 men, including the captain himself, wholly without provisions and fresh water, one survived 11 days, one 12 days, one 14 days, two 15 days, one 18 days, and the captain himself, who recovered, 28 days. Two men appear to have died early, furiously delirious, one (a lad, æt. 19) who died on the 12th day, was quietly delirious, with spectral illusions; two others were delirious, and Captain Casey had illusions of hearing.*

3. Of confinement in coal mines, we have instances of men and boys surviving 6 and 8 days, and one man 23 days. This was a case published by Dr. Sloan ('Med. Gaz.' vol. xvii. pp. 264 and 389). There was access to water for the first ten days.

4. The longest abstinence of food, with free access to water, of which I have had experience among prisoners, is ten days. In two men and one woman complete abstinence from food during this period was followed by no bad symptom, and the ordinary prison diet was resumed without injury to health. The prisoners were weakened, but by no means exhausted. (G.) In the case of ten days' starvation of a prisoner reported by Casper, scarcely any liquid was taken, and the exhaustion was much greater.—(Handbook, vol. ii. p. 28.)

The case of Bernard Cavanagh, though not one of complete abstinence, may be fairly added to the foregoing. Having been committed to gaol for three months, he was placed in a cell under the strictest surveillance, and refused to eat or drink. This continued, as it was alleged, nine days, at the end of which time he was reported to be in "perfect bodily health." But on the 13th day, it was remarked that the gruel supplied to him came back the same in quantity, but much thinner. This trick being discovered, and the man's health having by this time suffered, he was supplied with, and very gladly received nourishing food. ('Medical Times,' December 4, 1841.)

But we have well-authenticated cases extending much beyond

* The 'Times,' February 7, 1866.

ten days. There is Hufeland's curious case of the ruined merchant, a suicide by starvation, who kept a diary of his sensations for 13 days, and died on the 18th (G. H. Lewes' 'Physiology of Common Life,' vol. i. p. 25); the case of Viterbi, who survived 21 days; of Cecilia Rygeway, reported to have survived 40 days, and a case of 42 days briefly attested by Van Swieten. The first of these two cases is thus epitomised by the author of an article on Fasting Girls, published in 'All the Year Round,' Oct. 9, 1869. "Cecilia de Rygeway, having been imprisoned in Nottingham jail for the murder of her husband, during the reign of Edward III. (the year 1357) remained 'mute and abstinent' for 40 days, neither eating nor drinking during this time. It was considered so much in the nature of a religious sign or miracle that Dame Rygeway was pardoned by the King." The second case is briefly mentioned by Van Swieten in his 'Commentaries on Boerhaave's Aphorisms' (heading, Melancholy Madness): "I knew a woman," he says, "who obstinately refused all kinds of nourishment for six weeks, drinking nothing but a little water at intervals, so that at length she perished quite juiceless and dried up."

Willan's well authenticated and minutely detailed case of voluntary starvation* occurred in the person of a young man, a religious maniac, who drank water and a little orange juice, but ate nothing, and lived 61 days, and then, being cautiously fed, other 18 days. This survivorship of 61 days without food gives an air of probability to the French case of Guillaume Granét, the prisoner of Toulouse, which was reported to the Academy of Medicine, as follows:—He resorted to starvation to avoid punishment. For the first seven days the symptoms were not very remarkable; his face was flushed, his breath foul, and his pulse small and feeble. After this period he was compelled to drink water occasionally, to relieve the excessive thirst which he suffered, but in spite of the close watch kept over him, he frequently drank his urine, or the water of the prison kennel. His strength did not appear to fail him during the greater part of the time, and, with varying symptoms of constitutional disturbance and acute

* Miscellaneous works of the late Robert Willan, M.D., F.R.S., &c., edited by Ashby Smith, M.D., 1821 (p. 437). Willan, in commenting on this case, cites the following cases:—

1. In the 'Mémoires de l'Académie des Sciences,' 1769, that of a madman who lived 47 days without anything but a pint and a half of water per day. He stood constantly in the same position for 38 days of that time, but during the remaining eight lay down, and then took nothing, not even water. When he first began to eat again, he recovered his reason, but soon relapsed.

2. 'Edin. Med. Essays,' vol. vi. A case of a young girl, who fasted, at one *time*, 34 days, at another 54 days, from a spasm or some obstruction of the *œsophagus*.

sufferings, he lingered till the fifty-eighth day, when he expired, after struggling four hours in convulsions.*

From the best authenticated cases of prolonged absence from food, whether voluntary or involuntary, we infer that though life may be prolonged up to the limit of about two months, such abstinence is attended by progressive and rapid loss of weight, and at length by extreme emaciation. If, then, it were alleged by, or on behalf of, some man, woman, or child, that there had been a total abstinence from food for some period exceeding two months; or abstinence, not from food only, but from water also, for some such period as one month, we should be justified in looking on the case with the utmost possible suspicion, especially if the person so abstaining, having anything approaching the plumpness and fresh colour belonging to health, were to assert that no action of the bowels or bladder had taken place. If these things were present to justify the strongest suspicion, the making such person the subject of exhibition, and still worse, of gain, would add indignation to doubt, and leave us no alternative but to demand the decisive test of the closest surveillance.

Two English cases, in which this severe test was applied, are on record. The one is that of the Fasting Woman of Tutbury, the other of the Fasting Girl of Wales; for we pass over all cases not thus tested. Ann Moore, the Fasting Woman of Tutbury, was 58 years of age in 1808, when she asserted that she had gone twenty months without food. She alleged that four years before that date she had a severe attack of illness which lasted thirteen weeks, and that her recovery was not complete; for she was subject for months afterwards to violent fits and spasms at frequent and irregular intervals. A year later she had another severe illness that lasted eleven weeks, and was followed only by loss of appetite and indigestion, increased in 1806 by nursing a boy affected with a repulsive disease. From October in that year to February, 1807, she ate a penny loaf in a fortnight, and drank a little tea without milk or sugar. From that time till November, 1808, she lived, she said, only on water and tea. The case having been published in the 'Monthly Magazine' early in 1809, created a great sensation, and led to donations of money, on which the woman lived four years. But, in 1813, a few scientific men in the neighbourhood determined to sift the matter to the bottom. They got her to consent to have her room guarded and watched. This was done during nine days, at the end of which time she gave in, being terribly emaciated, and now really almost starved to death. She asked for food, recovered her strength, and set

* Foderé, vol. ii. p. 276.

Welsh Fasting Girl is taken from Dr. Fowler's
a special interest from the prominent part p
in the case from first to last.*

Sarah Jacob, daughter of Evan Jacob, a resp
tenant farmer, was the third child of a healt
living in a mean-looking house, with thatched
in which the girl and her parents occupied th
room. She was born May 12, 1857; her ca
public attention in 1867, when she was more
and she died December 7, 1869, little more
age. She was a fair, good-looking child, intellig
impressionable and emotional, fond of finery,
reading of religious books, and the reciting
verses. In February, 1866, when nearly nine
an attack of scarlet fever, followed by acute p
vomiting of blood; and from this time, as it
her bed. The pain and vomiting were soon
convulsions, with arching backward of the b
of pleurisy. The body remained rigid for
little food, and grew thin. In April, 1867, a
inflammation of the brain, and about this tim
taken no food for a month, though the lips w
time to time with beer, and only scanty eva
kind were passed. After the inflammatory attac
The fits, which had been convulsive, now cha
of consciousness, with sudden wakings and thr
arms; and the left leg was stated to be rig
October of this year (1867), she is said to have

girl took no food whatever for two years and two months, and the last week of watching; and nevertheless, during the first three weeks of this total abstinence, the bowels were not only frequently and largely relieved (possibly of matters collected previously), but that the usual quantity of water was passed for several weeks, that the hair which had fallen off grew again, thick and long, that her naturally healthy look was more than maintained, and her bulk apparently increased.

It was at the period to which we are referring (October, 1867) that visits of curiosity commenced, and soon became common, followed by their natural consequences—presents of money and books, mostly religious. The girl was gaily and fantastically dressed, and got up for show, somewhat after the fashion of a bride. By the end of the year 1868, the case became so notorious that visits grew more and more numerous, railways and local guides coming into requisition. A local reporter and several medical visitors now appear on the stage. In the spring of 1869, a public meeting was held, and a watching committee appointed whose inefficiency and failure are duly reported at p. 22 of Dr. Fowler's work. Other visits of inquiring and intelligent persons followed, and on the 7th September, 1869, Dr. Fowler wrote a letter to the 'Times,' giving the results of a careful and judicious inquiry carried as far as the parents would permit, and giving it as his opinion that Sarah Jacob was deceiving her parents, and that it was not possible to state what part of the symptoms resulted from "a morbid perversion of will," and what from "intentional deceit."

The complete publicity thus given to the case led, by steps not necessary to describe, to the selection of four trained nurses from Guy's Hospital, to visit and keep constant watch over Sarah Jacob, in order to ascertain whether she got food and drink, or not. Certain medical men were also selected as visitors. An early result of this procedure was to disprove one of the assertions made by the parents to the effect that the usual discharges from the bowels and bladder were absent. The history of the case from day to day is one of gradual loss of strength, development of feverishness, restlessness, and occasional delirium, progressive quickening of the pulse, and the exhalation from the body and breath of a very peculiar and highly offensive odour. In spite of the warnings given to the father, no food or drink was supplied, and on the eighth day the girl died exhausted and insensible.

On the 21st December, 1869, an inquest was held, and evidence given as to the state of the body after death. It was plump

and well formed, and covered with fat from half an inch to an inch thick, there was no obstruction in any part of the alimentary canal, and all the important organs of the body were sound. The body was perfectly free from disease. The jury brought in a verdict to the effect that Sarah Jacob died from starvation caused by the father's neglecting to induce the child to take food. The father was accordingly committed for manslaughter, but admitted to bail. The case was then taken up by the Government, and on the 26th February, 1870, summonses were served on the five medical men who had been in attendance during the watching, and on the parents of the girl; and a ten days' inquiry was held before the bench of magistrates, adjourned, and resumed. The result of the inquiry was the acquittal of the medical men, but the committal for trial at the next assizes of the parents, Evan and Hannah Jacob. On the 13th July, 1870, the grand jury found a true bill, and the following day the trial took place, which issued in a verdict of guilty against both parents, with a recommendation to mercy of the mother.

Sarah Jacob evidently succumbed to the same form of starvation that proved fatal to the three who died among the thirteen shipwrecked sailors whose cases are given above, and to those who perished soonest among the eighteen, of whom Captain Casey was the solitary survivor on the 28th day. The death, certainly not due to disease of any vital organ, or to obstruction of the alimentary canal, took place by exhaustion before there had been time for that long-continued and progressive absorption of the fat and tissues of the body which occurred in the cases reported by Currie and Willan. To these quicker deaths, attended by only slight loss of substance, the analogy of medical nomenclature justifies us in applying the term "*Acute Starvation.*" In the instances just adverted to we have cases of death in men under combined privation and exposure in less than twelve days (in one instance in eleven); and to these we have now to add the death of a girl of twelve and a half years of age, apparently healthy, but ill-prepared for total abstinence from food and drink by more than two years spent chiefly in bed, dating from a recovery not complete from a series of maladies, comprising scarlet fever, acute gastric derangement, symptoms attributed to inflammation of the brain, pleurisy, and anomalous rigid spasms of some continuance.

If the term *acute starvation* be accepted as descriptive of the cases just referred to, and the limit of survivorship be taken at *two weeks*, we shall be justified in classing under the head

chronic starvation, those instances in which the abstinence from food (complete, or nearly so) has extended to the extreme limit of *two months*. In the first class of cases, the body may be found well nourished; in the latter reduced to the extreme of thinness, described by Dr. Willan as "emaciated to a most astonishing degree," his whole appearance suggesting "the idea of a skeleton prepared by drying the muscles upon it in their natural situations;" or, to repeat the words of Mr. Biggs (p. 343), looking "like a skeleton with the skin tightly stretched over him;" so that "he could not only see each bone but its peculiarities."

PART III.

TOXICOLOGY.

The frequent occurrence of cases of real or supposed poisoning, and the complicated nature of the questions to which they give rise, render this not only the most interesting, but the most important division of Forensic Medicine; while the great number of recognised poisonous agents causes it to occupy no inconsiderable part of every medico-legal treatise.

Before proceeding to treat of the Poisons in detail, certain questions relating to poisons and poisoning in general will have to be discussed, such as the definition of the word poison, the mode of action of poisons, the causes which modify their action, and the classification of which they are susceptible.

It will also be necessary to point out the means we possess of answering the many questions which present themselves for solution when a suspicion of poisoning has been raised, and we are required to determine whether it is well or ill founded. Under this head we shall have to discuss the inferences that may be drawn from the origin and progress of the symptoms which gave rise to the suspicion; the value and significance of post-mortem appearances when death happens; and the light that may be thrown upon the case by experiments on animals, by chemical analysis, and by the conduct of suspected persons.

Again, the precautions which ought to be observed in conducting post-mortem examinations in cases of suspected poisoning, and those equally important which should be borne in mind in the several steps of a chemical investigation, ought to be very carefully examined and explained.

These leading divisions of the subject of poisoning will be treated, with some detail, in three separate chapters, being so many departments of the principal subject of Poisons in *General*.

CHAPTER I.

DEFINITION OF A POISON: ACTION AND CLASSIFICATION OF POISONS.

1. *Definition of a Poison.*—The *meaning* which ought to attach to the word poison is best ascertained by a simple process of exclusion. A substance which affects one person through peculiarity of constitution, but has no effect on others, is not a poison: a substance which owes its effect to some temporary condition of system, as when cold water is swallowed by a person heated by exercise, is not a poison: substances which mechanically injure and inflame the internal parts, such as pins and needles, and particles of steel or glass, are not poisons: again, hot water, the water being merely a vehicle for heat, is not a poison. Substances, therefore, which owe their action to some peculiarity of constitution, or unusual condition of the body; and mechanical irritants, and harmless substances rendered injurious by extraneous causes, are not properly termed poisons. Nor does the mode of application to the body form any part of the definition of the word poison. Whether applied to the skin, or inhaled, or swallowed, or introduced into the anus or vagina, or into the ear, it is still a poison. Again, the quantity that may prove fatal, or the time required to destroy life, cannot enter into the definition; for in both these respects undoubted poisons differ widely from each other. Lastly, the form of the substance or matter, whether solid, liquid, or gaseous, must be held to be immaterial. These exclusions have narrowed the possible definition of a poison, so that the following may be accepted as sufficient for every practical purpose:—A poison is any substance or matter (solid, liquid, or gaseous) which, when applied to the body outwardly, or in any way introduced into it, without acting mechanically, but by its own inherent qualities, can destroy life.

In the great majority of cases poisons are swallowed. They are given, "*administered to*," or "*taken by*" the person injured or killed; but they have been introduced into the body through the lungs, rectum, vagina, or ear, and they might be inserted

into the nostril. They have also been applied to the skin unbroken or abraded. Now though the words "*administer to*" and "*taken by*" are used in §§ 11, 14. 23, 24, of the "Act to consolidate and amend the Statute Law of England and Ireland relating to offences against the person," 24 and 25 Vict. 1861, the word "*apply*" ("apply or administer to") is used only in § 22, in reference to "chloroform, laudanum, or other stupefying or overpowering drug, matter, or thing." It is to be regretted that the same full and explicit phraseology was not employed in all the sections of the Act.

The word "poison" is often qualified by such terms as "active," "virulent," "deadly," and the last of these terms is very generally used in indictments.

A "deadly" poison may mean one that is fatal in a small dose, or kills quickly in a larger one, or which, irrespective of the dose, is more dangerous or difficult to counteract than others. Strychnia and oxalic acid, for instance, are both "deadly poisons;" but while less than a grain of the one may destroy life, about half an ounce of the other is a fatal dose; yet a full dose of oxalic acid may kill much more quickly than even a large dose of strychnia. On the other hand, the fatal dose of Epsom salts or sulphate of potash is two or three ounces, and even those quantities would not prove certainly or rapidly fatal; so that it would be incorrect to call these substances "deadly poisons." Nor would the term be rightly applied to such a substance as sulphate of zinc, which is often prescribed as an emetic in doses of a scruple or half a drachm; or to the non-corrosive preparations of mercury, iron, or copper. In any case the term "deadly poison" is open to the objection of raising an unnecessary verbal question; and when used in indictments should be treated as mere "legal surplusage," in accordance with the wise dictum of Mr. Justice Erle.

"A destructive thing," a phrase also used in the statute just referred to, if not a poison properly so called, must be some substance, or matter, which kills by a mechanical action on the internal parts, or by some adventitious property, such as heat. Particles of glass or steel, by irritating the lining membrane of the alimentary canal; and pins and needles, by wounding vital organs, or inflaming less important parts, may be fairly regarded as "destructive things;" but it is doubtful whether the term would apply to such matters as sponge, or plaster of Paris, which may destroy life by blocking the passage of the intestines.

Having defined the term "poison" with sufficient precision to indicate the matters which will have to be examined in the following pages, certain general questions relating to poisons must

next be considered. These are,—*Their mode of action*, and *The causes which modify their action.*

2. *Mode of action of Poisons.*—This is twofold, *local* and *remote.*

Their *local* action may consist in *corrosion*, or chemical decomposition, as when a strong acid, a pure alkali, or a corrosive salt, is applied externally or taken internally: in *inflammation*, followed by adhesion, suppuration, ulceration, or gangrene, when such irritants as arsenic, tartar-emetic, or cantharides, are similarly taken or applied: and lastly, in an effect on the nerves of sensation or motion. The numbness and tingling of the lips, tongue, and throat, occasioned by chewing monkshood, the sharp pricking sensation in the tongue caused by the arum maculatum, and the numbness of the skin which ensues on the application of prussic acid, chloroform, or veratria, are instances of local action on the nerves of sensation; while the palsy, due to the direct application of opium, ticunas, or prussic acid to the muscles, the dilatation of the pupil from the application of belladonna, and its contraction under the use of the Calabar bean, illustrate the same local action on the tissues of the iris.

The *remote* action of poisons is also twofold, *common* and *specific.* Their *common* effect is that which would result from any severe injury to the same part; their *specific* effect such as the poison alone can produce. The two effects, or modes of action, may be noted in the symptoms caused by such a poison as arsenic, which when swallowed, and so applied to the lining membrane of the alimentary canal, gives rise to the same cramps in the extremities that are present in cholera, English and Asiatic, and in all acute inflammations of the same membrane: but the same poison, inserted into a wound, applied to the skin, or inhaled, inflames the mucous surfaces with which it does not come into immediate contact. This is its specific action. Again, oxalic acid, which acts on the stomach as a corrosive and violent irritant, causes the same constitutional shock which attends all severe local injuries: this is its remote common effect; but it has also a remote *specific* effect on the heart and nervous system. The purest example of a remote constitutional effect of a common kind is afforded by the mineral acids, and the alkalis and their carbonates, which, by the local destruction they occasion, give rise to the symptoms of collapse present in extensive burns and scalds. This absence of remote specific effects has led some authors to doubt the propriety of classing these chemicals among poisons.

The remote specific effects of poisons may also be distinguished as *general* and *partial*—that is to say, as producing a general

effect on the whole frame, or a partial effect on a particular organ or texture.

A knowledge of the *specific* remote action of poisons is of the first importance, for it often enables us to define the class to which a poison belongs, and even to indicate the very poison itself. Thus, stupor points to the action of some member of the narcotic class; delirium to the class which comprises belladonna, hyoscyamus, and stramonium; paralysis, or great loss of muscular power, to the action of hemlock, tobacco, digitalis, aconite, or the Calabar bean; tetanic spasms would lead us to infer the action of strychnia; arsenic sets up inflammation in the mucous membranes; mercury attacks the salivary glands and mouth; cantharides the urinary system; antimony the lungs; manganese and copper the liver; chromate of potash the conjunctiva, iodine the lymphatic glands, lead the muscular system; phosphorus produces fatty degeneration, and spurred rye produces gangrene of the limbs. Poisonous substances used in the arts also reveal themselves through their specific actions. Thus the dropped hand betrays the use of lead, paralysis agitans that of mercury, gangrene of the jaws that of phosphorus, and a peculiar rash about the nostrils, ears, bends of the arms, and scrotum, that of the arsenite of copper.

These brief statements might lead to serious mistakes if it were not understood that some constant symptoms of the poisons just enumerated are also occasional symptoms of other poisons. Thus, tetanic spasms, though characteristic of the action of strychnia, may occur in poisoning by morphia and other of the alkaloids, as well as by arsenic, corrosive sublimate, and tartar-emetic. Salivation, again, may result from poisons other than mercury, and the dropped hand from the preparations of arsenic as well as from lead. Nor should it be forgotten that these are but the leading phenomena among a considerable group of less characteristic symptoms. Thus severe irritation of the alimentary canal, inflammation of all the mucous surfaces, a rapid pulse, a series of acute nervous symptoms, and a cutaneous rash, may all occur in a case of arsenical poisoning; and the same is true of oxalic acid and the salts of mercury. It must also be understood, that many of the best-marked symptoms of poisoning are also symptoms of diseases—a fact that will be fully illustrated in the section of this chapter which treats of the Evidence of Poisoning.

In producing their remote specific effects, poisons must either be carried with the blood to the parts affected, or their action on the nerves of the part to which they are applied must be pro-

pagated to the nervous centres, and thence reflected on the organs remotely affected. Now there is abundant proof of the absorption of poisons, and their circulation through the system, and experiments on animals have shown that this takes place in whatever way the poison is applied or introduced. By the analysis of the blood, secretions, and solid textures, the poisons are further proved to have circulated with the blood; and the list of poisons thus detected includes every substance which can be recognised by its odour or colour, or which, not having been completely decomposed, can be submitted to chemical reagents. The fact of the absorption of poisons is therefore established and admitted; but the question arises—Is the fatal action of poisons due to their absorption? This question will be answered in the affirmative if it can be shown, on the one hand, that poisons continue to act so long as the blood passes freely from the point of insertion to the tissues or organs affected, and that, on the other, their action is stopped or postponed when the circulation is arrested.

Magendie's well-known experiment in which a poisoned limb was connected with the body only by quills introduced into its large vessels, and yet the poison continued to act, establishes the first proposition as true of wounds; while Mr. Blake's experiment with prussic acid introduced into the stomach through an opening in its walls, the poison producing no effect so long as the vessels passing from the stomach to the liver were secured by ligature, but beginning to act within one minute of its removal,* proves the second proposition as true of poisons that are swallowed. That the great nervous trunks cannot transmit the poisonous influence, is proved by the facts that poisons inserted into a limb connected with the body by nerves only are inactive; that division of the spinal marrow does not prevent the action of those poisons which prove fatal by attacking that part; and that the direct contact of poisons with the substance of the brain itself is innocuous.

It appears, then, that poisons, whether inserted into wounds or introduced into the stomach, act by absorption, and that, when absorption is prevented, and the circulation arrested, they cease to act. It is only indeed when it enters the circulation that the poison can be truly said to be introduced into the body. A poisonous substance taken into the stomach is as much outside the system as if it were applied to the skin.

The question now arises—In what way do poisons, circulating

* 'Ed. Med. and Surg. Journal,' vol. liii. p. 45.

through the system, produce their fatal effects? On what tissues and organs do they act?

It is plain that all poisons do not destroy life in the same way. Some paralyse the heart, others act directly on the lungs, and suffocate; a third class attack the brain; a fourth the spinal marrow; and a fifth appear to affect the entire capillary circulation. Morgan and Addison tried to prove that these different modes of death were due to some powerful influence transferred to the organ or tissue affected, through the nerves of the blood-vessels themselves; but an experiment by Mr. Blake, in which blood poisoned with woorara continued to traverse the arteries and veins of the abdominal viscera for several minutes before any effect manifested itself, affords a sufficient refutation of this hypothesis. Important additions have been made to our knowledge of the action of poisons, and of the proximate cause of death in poisoning, by M. Claude Bernard. He showed by well-devised experiments on animals that the more active poisons kill by attacking particular tissues or organs—that woorara paralyses the motor nerves, that strychnia attacks the spinal cord, and excites fatal reflex actions, that digitalis, upas antiar, corrowal, and wao, veratria, and several other poisons, act on the muscular tissue throughout the body, and on the heart as a muscle.*

There remains, then, but this explanation of the fatal action of poisons—that they are carried with the blood to the organs or tissues on which they act, some by the coronary arteries to the heart, which they paralyse; others to the spinal marrow, exciting fatal tetanic spasms in the respiratory muscles; others to the brain, proving fatal by an indirect action on the respiration; and others, again, to the lungs, arresting the capillary circulation, and killing by suffocation.

This theory, of the necessity of absorption to the action of poisons, had to encounter a difficulty in the rapidity with which certain poisons, such as prussic acid, prove fatal; but this was removed by Blake's ingeniously contrived and carefully-performed experiments. Having provided a delicate measure of the state of the circulation by inserting into the femoral artery of the animal experimented on the hæmadynamometer of Poiseuille, he introduced directly into the vessels various substances previously known to paralyse the heart, and noted the instant of time at which the first effects of the poison showed themselves, and at which the heart ceased to beat. He found that a poison passed from the jugular vein to the lungs of a dog in from four to six seconds; to the coronary arteries of the heart in seven; to the carotid artery

* Lectures in 'Medical Times and Gazette,' 1850, vol. ii. Nos. 532, 3, and 5.

in from five to seven; and from the aorta to the capillaries in four seconds. A poison introduced into the jugular vein was distributed through the whole body in nine seconds. In the horse, the circulation was completed in from twelve to twenty seconds, or somewhat less than the twenty-five seconds deduced by Hering of Stuttgardt from his experiment.

These experiments are confirmed by the more recent ones of Claude Bernard. A saturated solution of sulphuretted hydrogen, introduced into the jugular vein of a dog, began to be eliminated from the lungs in three seconds; and when injected into the femoral vein of the same dog, in six seconds.

The time required for the circulation of a poison through the body of a dog being taken at nine seconds, it follows that if poisons applied to the dog's tongue do not act in so short a space of time, absorption may take place, and the blood may be distributed to the organ on which it produces its fatal effects. Now, Blake found that strong hydrocyanic acid applied to the tongue of a dog did not begin to act till eleven seconds, and did not kill till thirty-three seconds; and when a tube was previously introduced into the larynx, so that the vapour of the acid did not enter the lungs, the first symptoms did not show themselves till sixteen seconds, and death did not take place till after the lapse of forty-five seconds. Nicotine, the essential principle of tobacco, applied to the tongue of the same animal, did not kill till twenty seconds. These experiments would suffice to prove the necessity of absorption to the fatal action of poisons, but for a small group of well authenticated cases in which poisons have destroyed life instantaneously, or much more promptly than in any of Blake's experiments. Thus Christison states that an animal has been killed outright by prussic acid in four seconds;* and cases are cited by the same author, and by Dr. Taylor,† in which the same poison killed in three, and even in two, seconds; and in the experiments of Sir Benjamin Brodie, alcohol and the essential oil of bitter almonds seem to have had the same instantaneous effect.‡

In presence of these facts, and with the knowledge we have of the instantaneous impression, or shock, produced by extensive mechanical or chemical injuries, it must be admitted that the more active poisons taken in large doses may destroy life by a sudden nervous shock.

A fact reported by Sir B. Brodie renders it probable that

* 'Treatise on Poisons,' p. 7.
† 'Medical Jurisprudence,' 5th edition, p. 160.
‡ 'Physiological Researches,' p. 136.

poisons may act through continuity of tissue. A man was bitten in the hand by a rattlesnake. Inflammation, sloughing, and suppuration of the cellular tissue of the arm followed, with copious and extensive extravasation of blood beneath the skin of the chest and back, limited to the injured side of the body.

The theory of absorption finds a practical application in the use of ligatures, cupping-glasses, and lip-suction, in the case of poisons inserted into wounds.

3. *The causes which modify the action of poisons* are three in number:—1. *Their quantity and form.* 2. *The part to which they are applied.* 3. *The condition of the body itself.*

1. *Quantity and Form.*—*Quantity.*—As a general rule, the larger the quantity of a poison the more prompt and severe its action; but when poisons are swallowed, a large dose may be immediately and completely discharged by vomiting, while a smaller dose will remain on the stomach, and prove fatal. The action of some poisons also varies remarkably in kind as well as in degree with the quantity taken. Thus a large dose of oxalic acid may kill almost instantly by shock; a smaller dose may still prove fatal by acting on the heart; a yet smaller dose affects chiefly the spinal cord; and a more minute dose still, the brain. Again, small repeated doses will develope other symptoms than a single large dose. Of the whole class of narcotico-acrid poisons, it may be affirmed, that in large doses they act chiefly on the nervous system, in smaller doses on the alimentary canal.

Form.—Under this head will have to be considered—*a. State of Aggregation. b. Chemical Combination. c. Mixture.*

a. State of Aggregation.—Solution increases the activity of poisons, both by promoting absorption and by applying them to a larger surface. Soluble poisons, therefore, are the most active, soluble salts more active than their less soluble bases, and volatile poisons act with great energy on the lungs and skin.

b. Chemical combination.—Such poisons as the mineral acids and the alkalis lose their active properties when neutralized; and, as a rule, the salt resulting from the union of acid and base is more or less active as it is more or less soluble. Acid poisons, in combining with bases, or basic poisons combining with acids, conform to the same rule, and the resulting compounds, if soluble, retain the specific characters of their active ingredient. Thus all the soluble salts of morphia have the same action; and the same is true of all the soluble compounds of oxalic acid. When two poisonous substances combine (as arsenious acid with copper, or prussic acid with mercury or silver), the resulting compound may give rise to the symptoms of the more active, to the mixed effects

of the two, or to symptoms peculiar to itself. Lastly, some poisons insoluble in water, as arsenite of copper, and carbonate of lead or baryta, may be rendered soluble and active by the acid juices of the stomach, or by the secretions of the skin.

c. Mixture.—All admixtures which render a poison more soluble make it more active: all others have a contrary effect. Thus acids increase the activity of opium, and of the salts of copper, and water of arsenic; but oily, mucilaginous, albuminous, and starchy liquids retard the action of poisons by protecting the coats of the stomach, by involving the poison, if in substance or powder, or even by acting as antidotes. Hence the frequent escape of those who have taken large doses of arsenic or corrosive sublimate with, or directly after food. Much also depends on the character of the food. Thus arsenic in a solid dumpling would act much more slowly than in porridge, and in porridge than in the liquids in common use; and strychnia in a pill would act more slowly than in a mixture. We avail ourselves of the protective effect of the thick liquids just mentioned in the treatment of cases of poisoning, and we administer substances that have little power as antidotes, because they have the property of withdrawing and holding in suspension certain poisons. Powdered charcoal is the best example of this class; and magnesia and the sesquioxide of iron owe their repute, as antidotes to arsenic, chiefly to this property.

2. *Part to which the Poison is applied.*—The effect of a poison on different parts of the body is directly as their absorbing power. Thus poisons act most promptly when inserted into a wound; the serous surfaces hold the next place; then the stomach; then the unbroken skin. Injection into a vein insures the quickest action; but volatile poisons introduced into the lungs act with nearly as great rapidity. The corrosive poisons and stronger irritants produce an effect proportioned to the importance of the part to which they are applied. Thus, the mineral acids prove speedily fatal when they attack the windpipe; less speedily when they act on the gullet and stomach, and they must destroy a large surface of skin in order to kill quickly. Many animal poisons, such as the poison of the viper or mad dog, and also curara, introduced into the system in minute quantity, by puncture of the skin, kill very quickly, though the same small quantity, and even a much larger dose, may be swallowed with impunity.

This remarkable fact can now be explained on physiological grounds. A certain quantity of the poison must be present in the circulation before it can manifest its effects. If the excre-

tion is as active as the absorption, no effect will be produced. Hence a poison like curara, taken into the stomach, is not absorbed more quickly than it is got rid of by the excretory organs. If, however, the function of excretion is impeded by ligature of the renal artery, the introduction of the poison into the stomach will develope the symptoms of poisoning just as certainly as if it were conveyed into the circulation by a wound.

3. *Condition of the Body itself.*—Under this head will have to be considered—*a. Habit. b. Idiosyncrasy. c. Disease.*

a. Habit.—No broad general rule can be laid down in reference to the influence of habit. Some vegetable poisons, such as opium, alcohol, and tobacco, lose their effect by repetition, and may at length be taken in doses which would poison a man not accustomed to their use; and the less deadly mineral poisons, such as the sulphates of zinc and iron, may be taken by healthy persons in continually increasing doses: but arsenic, mercury, and phosphorus, when used in the arts, and gradually introduced into the system, appear, like the carbonate of lead, to be more dangerous the longer they are used. Nor do men and women who work with arsenite of copper grow more tolerant of the poison. The same effects are reproduced at each resumption of their employment. The stomach may, however, become accustomed to poison, and grow nearly insensible to it, as happens with the spirit-drinker. It should, however, be borne in mind that even those poisons to which the system most readily adapts itself, produce permanently injurious effects. Thus alcohol causes disease of the lungs, liver, kidneys, and brain; tobacco quickens the pulse; and opium injures the digestion, emaciates the body, and enfeebles the mind.

b. Idiosyncrasy.—Under this term are included certain peculiarities of constitution, of the true nature of which we are ignorant. Some of them may be explained by the physiological relation between the two processes of absorption and excretion; but there are others of which we can give no satisfactory explanation. Peculiarity of constitution may show itself in two ways—1. By a greater or less susceptibility without difference of action. Thus, a few grains of mercury shall salivate one man, but as many drachms or ounces shall not affect another. 2. By exceptional action. Thus, Epsom salts have been known to act like opium, and opium to have a purgative effect; and a simple article of diet, which is the daily food of other men, shall act like a poison on a few individuals. Thus, certain kinds of meat, fish, fruit, and vegetables act like irritant poisons on some

persons. Even mutton has been known to act invariably in this way.

c. Disease.—This, as a general rule, renders the body less susceptible of poison. Thus, patients reduced to extreme weakness by fever or other causes, are scarcely affected by stimulants which would overpower the strong. In continued and in yellow fever there is increased tolerance of mercury, but in paralytic affections, and anæmic states, an opposite condition prevails; in anæmia, large doses of preparations of steel are readily borne; and in severe dysentery, cholera, and hæmorrhage, large quantities of opium; in all the more severe affections of the nervous system, every remedy, but especially the narcotic poisons, may be given in greatly increased doses. Delirium tremens may be safely and successfully treated by half-ounce doses of tincture of digitalis, and opium may be given in one form of mania in repeated doses of two scruples. The only exception to the general rule is in the case of poisons which give rise to symptoms similar to those actually existing. Thus, the irritants would increase gastritis, diarrhœa, or dysentery; and the narcotics exasperate a determination of blood to the brain, or an attack of uræmia.

There is still one condition of system which deserves mention as tending to impair the effect of poisons—viz., sleep. In this state all the functions are carried on more languidly, and the body is less alive to the action of medicines and poisons. This is true of sleep artificially induced, so that narcotic poisons given with or before other poisons, must weaken or counteract their effects. Opium, for example, when given with arsenic, not only masks the symptoms proper to that poison, but appears to retard its operation.

4. *Classification of Poisons.*—There are only two principles of classification which commend themselves to the judgment as logically sound and practically useful. The one arranges the poisons according to their source, the other in accordance with their action on the system. When the first principle is adopted, poisons are arranged as inorganic and organic; or in three leading classes—mineral, vegetable, and animal; when the second is preferred, it is usual to arrange them also in three classes—irritants, narcotics, and narcotico-irritants. The first classification is open to the obvious objection that though almost all the poisons from the mineral and from the animal kingdoms are irritants, those from the vegetable kingdom comprise, in addition to simple irritants, a great number of poisons which, under any conceivable arrangement, must be distributed into

many distinct groups. On the other hand, a classification based on the mode of action of poisons is subject to the inconvenience of separating from each other poisons derived from the same kingdom of nature, and, for that reason, presenting analogies and contrasts of chemical composition which render their juxtaposition extremely convenient.

By no possible classification, therefore, can we reconcile the conflicting requirements of physiology and natural history, or satisfy those who seek in all such arrangements the highest scientific accuracy. But those who see in classification rather an instrument of convenience than an expression of abstract truth, will be ready to acquiesce in any grouping which brings into closest contact those objects that can be best studied when they precede or follow each other, and concerning which, when so placed, certain general principles can be laid down. The scheme which best fulfils these conditions will be set forth and explained when some of the existing classifications have been described and examined.

The division first proposed by Foderé into *irritants*, *narcotics*, *narcotico-acrids*, and *septics*, rests on a physiological basis, as does also the more generally accepted triple division which excludes the last, and retains the other three. But the best toxicological writers have grown dissatisfied with the third group of narcotico-acrids, as offending against every sound logical principle, and have endeavoured to reconstruct the classification of poisons on a sound physiological basis. The most ambitious, but least successful, attempt is that of Tardieu;* that of Casper is scarcely an improvement upon it:† the scheme of Dr. Taylor is less open to objection.‡ After carefully examining these schemes, and the juxtapositions to which they give rise, we prefer a compromise between the claims of physiology and natural history. We first divide the whole body of poisons into *inorganic* and *organic*, and then distribute each into appropriate sub-classes: the inorganic into *corrosives* and *irritants*, the organic into *irritants*, and such as destroy life by their action on the *brain*, *spinal cord*, *heart* and *lungs* respectively. The irritation of the alimentary canal which marks the action of so many of the organic poisons, and justifies the use of the term *narcotico-acrid*, will be considered as subor-

* 1. Irritants et corrosifs. 2. Hyposthénisants. 3. Stupéfiants. 4. Narcotiques. 5. Nevrosthéniques (p. 167).

† 1. Irritant poisons. 2. Poisons which produce hyperæmia. 3. Nerve-paralysing poisons. 4. Poisons which produce marasmus. 5. Septic poisons (Handbook, p. 44).

‡ 1. Irritants. 2. Neurotics, distinguished as cerebral, spinal, and cerebro-spinal ('Medical Jurisprudence,' p. 136).

dinate to the more important effect produced on the nervous centres, on the heart, or on the lungs. The classification, as far as it is necessary to explain it in this place, will therefore be as follows:—

Poisons.

1. Inorganic. { *a.* Corrosive. *b.* Irritant.
2. Organic. { *a.* Irritant. *b.* Affecting the brain. *c.* „ „ spinal cord. *d.* „ „ heart. *e.* „ „ lungs.

The two leading classes of inorganic and organic poisons figure in the bills of mortality for 1852-6 as causing respectively 77 and 191 deaths out of the 268 due to poisons distinctly specified. 133 deaths caused by poisons not identified, being added, makes up a total of 401 deaths as ascertained to have been produced by poison on the average of those years. It will be seen that out of 100 poisons proving fatal, 29 would be inorganic, and 71 organic. The most important poisons of the two classes are shown by the following figures:—*Inorganic:* arsenic 27, salts of lead 23, mineral acids 15, salts of mercury 10. *Organic:* laudanum, opium, morphia, and Godfrey's cordial 141, prussic acid, essential oil of bitter almonds, and cyanide of potassium 34, oxalic acid 13, strychnia and nux vomica 2.

Before dismissing the subject of classification, it may be well to point out some of the results of the plan now adopted as compared with that preferred in former editions of this work. Oxalic acid, which followed the corrosive mineral acids, and resembled them in the destructive effects of its stronger solutions, is now grouped with prussic acid, which it as nearly resembles in the promptness of its action and marked effect on the nervous centres; and cantharides and its active principle, cantharidine, with some other important poisons, are removed from the irritant to the organic group, in which will now be found every active principle of organic origin; so that these principles may now be treated as their great importance demands, with a view to their discrimination the one from the other: and the inorganic poisons can be similarly treated with like advantage. The illustrations of the poisonous plants will also be found side by side under a common heading.

CHAPTER II.

EVIDENCE OF POISONING.

Under the title at the head of this chapter it is usual to examine the circumstances which would lead us to infer that some poison has been taken. Among these circumstances those which contribute most directly to the formation of an opinion are the *Symptoms and post-mortem appearances: experiments on animals; chemical analysis; and conduct of suspected persons.* Valuable evidence is also afforded by *the symptoms and post-mortem appearances proper to the different classes of poisons.*

1. *Symptoms.* In most cases of poisoning the symptoms appear suddenly, in a person in good health, soon after taking food, drink, or medicine; and in most fatal cases, death happens in a few minutes, hours, or days.

The sudden appearance of the symptoms affords a presumption in favour of poisoning; for, in full doses, poisons act promptly. On the other hand, when given in small and repeated doses, the invasion of the symptoms may be gradual. It must also be recollected that many diseases of the vital organs—the brain, heart, and lungs—perforation of the stomach or intestines, and severe epidemic maladies, such as plague, cholera, yellow fever, continued fever, the febrile exanthemata, small-pox, scarlatina, and measles, set in suddenly with severe symptoms of indisposition.

The occurrence of the symptoms in a person in good health, also affords a presumption in favour of poisoning; but as many acute diseases suddenly attack healthy persons, and many sudden deaths occur in persons seemingly in rude health, too much stress must not be laid on this sign. It should also be borne in mind that poisons are sometimes given to the sick, and that after the health has been slowly undermined by repeated doses of some less active substance, such as tartar emetic, death has been suddenly brought about by a deadly poison, such as morphia, strychnia, or veratria. Witness the French case of Castaign, and the English cases of Palmer, Dove, and Pritchard.

The appearance of the symptoms soon after taking food, drink, or medicine, affords a stronger presumption; for large doses of the more active poisons act very quickly. But it must be recollected that vomiting and other symptoms of indisposition may set in after a wholesome meal; that a full meal is a common precursor of apoplexy; that rupture of the coats of the stomach, softened by previous disease, naturally takes place while the organ is distended with food; that English cholera may be caused by unripe fruits, putrid meat, or other unwholesome ingesta; and that a large draught of cold water swallowed while the body is heated, may cause instant death.

The presumption afforded by the symptoms occurring soon after a meal is greatly strengthened when other persons partaking of the same meal are similarly affected: but too much importance should not be attached to the absence of such effects in others; for the person in whom the symptoms have shown themselves may have partaken of some dish, or part of a dish, or of some wine or drink, which the others had not tasted.

The attack of several persons by similar severe symptoms, soon after a meal of which all have partaken, affords the strongest possible presumption of poisoning either by the food itself, or by some accidental or intentional admixture. If the symptoms are those of simple irritant poisoning, we cannot determine by the symptoms alone which of these alternatives is the true one; but they may be so characteristic as not only to prove the administration of a poison, but to indicate the very poison itself.

The simultaneous fatal attack of several persons in the same place, or on the same mission, in the absence of proof that they had partaken of the same food, would also furnish a strong presumption of poisoning. Thus, the death in one night of four of the eight peers selected to represent the Scottish nation at the nuptials of Queen Mary with the Dauphin of France, in 1558 (Lord Fleming at Paris, Bishop Reid, the Earl of Rothes, and the Earl of Cassilis at Dieppe) certainly justified the suspicion of poisoning, for which the refusal of the Scottish deputies to grant the crown matrimonial to the bridegroom had furnished a motive, by giving great offence to the French Court.*

A suspicion of poisoning is often successfully rebutted by the fact that no food, drink, or medicine had been taken for hours before the commencement of an illness attributed to a quickly acting poison. The inference would be somewhat weakened if sleep had occurred in the interval. In this place it may be well

* Sharp's 'Peerage'—Marquis of Ailsa.

to advert to the fact that poisons have been introduced into the anus or vagina, poured down the throat of a drunken or sleeping person, or inserted into the ear; and that the hypodermic method of administering active medicines is not unlikely to be resorted to by the better informed class of poisoners.

The rapid course of the symptoms towards a fatal termination affords but a weak presumption of poisoning; for many cases of poisoning end fatally after a considerable interval, and many acute diseases run a very quick course.

All the characters now mentioned are, therefore, to be received with caution, and carefully weighed. The joint occurrence of two or more of them would afford a strong presumption; and the coincidence of all, though not decisive, would justify a very strong suspicion. Thus, if a person in perfect health, soon after taking food, were attacked with severe and continued vomiting and purging, and died within twenty-four hours, a strong suspicion would naturally arise that the food had contained some poisonous substance; and the suspicion would be greatly strengthened if other persons who had partaken of the same food were similarly affected. The food itself might have had poisonous properties or the poison might have been added to it; but the probability of poisoning in one of these two ways is very strong; and the inference would be almost irresistible if it could be shown that the person affected had never suffered in the same way before, and that neither English nor Asiatic cholera prevailed at the time.

2. *Post-mortem Appearances.*—There are certain poisons and classes of poisons which leave in the dead body unmistakeable signs of their action. Mineral acids stain and corrode the parts with which they come in contact, and oxalic acid in strong solution, as well as one or two mineral corrosives, destroy the lining membrane of the gullet and stomach. Other poisons yield highly characteristic deposits. Thus corrosive sublimate, decomposed by the secretions and membrane of the stomach, or by its albuminous contents, leaves a slate-coloured deposit of finely-divided mercury; and arsenious acid in substance a white patch clinging to the inflamed membrane, which may be changed into the yellow sulphide by sulphuretted hydrogen, the product of putrefaction. Orpiment and Scheele's green, cantharides, and nux vomica, and the spores of poisonous mushrooms, also leave a coating of characteristic colour; phosphorus betrays itself by shining in the dark; and vegetable poisons are sometimes identified by seeds, or fragments of leaves left in the alimentary canal.

Other poisons, again, whether inorganic or organic, both those which have a simple irritant action, and those formerly classed as

narcotico-acrids, excite a more intense inflammation in the stomach and intestines than that due to disease. A less degree of inflammation, being common in those who die a natural death, would not justify a suspicion of poisoning; and the same remark applies to those appearances of congestion in the brain which are common to the action of the narcotics and narcotico-acrids, and to many cerebral diseases and disorders.

Great importance naturally attaches to the negative evidence from post-mortem appearances; such as the absence of corrosion in alleged cases of poisoning by corrosives, and of inflammation, after the alleged administration of an irritant or narcotico-irritant poison. The absence of congestion of the brain, in a case of imputed narcotic poisoning, would afford a lower presumption.

The absence of characteristic post-mortem appearances might also become important in the very improbable event of poison being introduced into the body after death, with a view to inculpate an innocent person.

Formerly undue importance was attached to unusual blackness or lividity of the skin, and to the early occurrence of putrefaction as evidence of poisoning. But there is no reason to believe that these appearances are more common after death by poison than after other forms of sudden or speedy death; and it is now well known that some of the mineral poisons—for instance, arsenious acid, corrosive sublimate, and chloride of zinc—preserve the parts with which they come in contact.

Post-mortem appearances similar to those produced by poison, even though confirmed by the discovery of the poison itself, would not prove that death has been caused by poison; for it might be due to some cause anticipating its fatal action. On the other hand, a dead body may bear marks of severe external injury, or extensive disease of the internal organs, and yet the real cause of death be poison.

The post-mortem appearances, then, though they furnish conclusive independent evidence in the case of several poisons, afford only a slight presumption in a larger number; but even when inconclusive in themselves, they may strengthen, by their presence, the presumption drawn from symptoms, or from moral evidence; or, by their absence, invalidate a charge prompted by malice.

3. *Experiments on Animals.*—These are very valuable both as affording evidence of poisoning, and as illustrating the mode of operation of poisons. Experiments, confirmed by happy accidents when domestic animals and poultry have partaken of the same food as the poisoned person, or have eaten the matters re-

jected from his stomach), have shown that the dog and cat, as well as poultry, are killed by the poisons which prove fatal to man, and that they die with symptoms similar to those by which he suffers; and when, as in poisoning by prussic acid, and strychnia, the effects of the poison are quickly developed with symptoms of a very marked character, the evidence from this source must be admitted to be conclusive. But even in the absence of any previous experience of the effect of poison on a healthy living creature, the death of such creature soon after the administration of a poison which is believed to have proved fatal to a man, affords the strongest evidence in favour of poisoning, even without taking into account the character of the symptoms. On the other hand, should the animal neither suffer nor die, the presumption in favour of the harmlessness of the substance under trial is very strong. When the substance supposed to contain poison is so abundant that it can be given to different animals, or when the matters rejected from the stomach happen to be eaten by them, the death of all the animals affords undoubted proof of poisoning.

In rare cases of poisoning of animals by arsenic or strychnia, good evidence has been afforded by the fatal effect on other animals of eating their flesh.

The value of the evidence from experiments on animals is affected by certain considerations arising out of the discrepant effects of the same poison on different living creatures. It has been ascertained beyond all doubt, that there is at least one insect that can feed and flourish on strychnia; and nearly half a century ago M. Runge, of Berlin, fed a rabbit exclusively for no less than eight days on the leaves of belladonna, hyoscyamus, and stramonium, and though he found that the poisonous principles had been taken up into the animal's body, the animal at the end of the time was as healthy as at the beginning; there was not even any dilatation of the pupil. Dr. W. Ogle, in a letter addressed to the *Times* in August, 1865, applies this fact to the case of Mr. Sprague, tried for attempting to poison the Chalker family, and acquitted; and deems it probable that the belladonna found its way into the poisoned pie through the flesh of a rabbit which had fed on the plant. This explanation must be admitted to be quite feasible, for it has been well ascertained that poisonous plants which prove harmless to insects, birds, and animals that use or consume them, may impart to the secretions and flesh of the creatures in question properties highly poisonous to human beings. Thus, the honey of bees collected from the calmia azalea and rhododendron, and even the mead made from them, has been

found poisonous. During the famous retreat of the 10,000 under Xenophon, the army suffered severely by eating the honey collected from the azalea pontica. The milk as well as the flesh, of cattle browsing on some of the herbage in South America has proved poisonous; as has the flesh of hares that had eaten the rhododendron chrysanthemum, that of pheasants that had fed on the buds and shoots of the calmia latifolia, and that of partridges that had partaken of certain berries during the Canadian winter, and had been imported into this country packed in ice; and as lately as September, 1862, Mr. F. Taylor, of Romsey, reported two cases of great severity from eating the Canadian partridge, and the case of a cat sickened and paralysed by the same cause. Some time since, several persons near Toulouse were poisoned by a dish of snails which had been fattened on the leaves and shoots of coriaria myrtifolia.*

It may be safely conceded, therefore, that certain poisons belonging to the vegetable kingdom may be consumed with impunity by insects, birds, and animals, and yet the honey collected by bees, the flesh of birds, and the milk and flesh of animals, if consumed by human beings, may occasion distinct, and dangerous, and even fatal, symptoms of poisoning.

To the evidence drawn from experiments on animals with matters rejected from the human stomach, or collected from the stomach and intestines after death, it has been objected that the animal secretions may be so vitiated as themselves to prove poisonous, and the objection has been enforced by a well-known experiment of Morgagni. The bile from the stomach of a child, who died in convulsions from tertian ague, mixed with bread and given to a cock, caused convulsions and death in a few minutes, and the same effect followed in two pigeons inoculated with it. But it is obvious that experiments with the bile of a diseased subject can have no proper application to cases in which food rejected from a healthy stomach has proved poisonous to animals. It is scarcely necessary to state that the negative result of experiments with substances rejected from the stomach, or found there after death, is not conclusive against poisoning, for the poisonous substance may have been evaporated, decomposed, absorbed, or previously rejected.

When there is reason to believe that we are dealing with a small quantity of poison, small animals, such as rats or mice, should be chosen for experiment; or the frog, as particularly suited for experiment with minute quantities of such poisons as strychnia. Leeches have also been suggested as applicable to

* 'Med. Times and Gaz.,' Sept. 13, 1862.

the same purpose. The hypodermic method of administering such active medicines as morphia and conia will evidently admit of extension to the identification of poisonous substances, as soon as sufficient data have been collected by well-devised experiments.* Those who desire to follow up this class of experiments should select for their purpose one animal, and by preference the dog.

In dealing with larger animals that vomit their food, and with poisons which act speedily, the gullet should be secured with a ligature.

The necessity of experiments on animals is now largely superseded by chemical analysis; but as the tests for some of the vegetable poisons are uncertain, such experiments, performed with care, are valuable, and have been admitted as evidence.

When experiments on animals are resorted to, in order to illustrate the mode of operation of poisons, or to determine some important question, such as the shortest time within which a dose of prussic acid may prove fatal, or the possible absence of marks of inflammation in the stomach after poisoning by some irritant, such as corrosive sublimate, choice should be made of the dog, as the animal of which we have the largest experience.

4. *Chemical Analysis.*—This form of evidence, though not absolutely necessary when the symptoms, post-mortem appearances, and circumstantial evidence confirm each other, or even when two of the three coincide, is always of the first importance. The poison may be discovered in the living person by tests applied to the urine, to the blood abstracted by bleeding, cupping, or leeches, or to the serum of a blistered surface; or it may be detected in the dead body in the blood, flesh, viscera, and secretions. In either case the discovery of the poison affords conclusive evidence of its administration.

When we are dealing with substances rejected from the stomach or voided by the bowels, with the contents of the stomach and bowels after death, or with food or medicine of which the sufferer has partaken, the evidence is obviously less conclusive, for objections may be raised on each of the three suppositions, that poison is detected, that it is not detected, or that it is found in very small quantity.

When a poison *is found* in the matters discharged during life, or left in the alimentary canal after death, or in food or medicine, it may be objected that it might have been accidentally mixed with it, or fraudulently, in order to inculpate an innocent

* Dr. John Harley's Gulstonian lectures given at the College of Physicians (1868).

party; in which case the evidence must be supported by proof that this could not have happened.

But when a poison *is not found* in any of the substances submitted to analysis, it does not follow that none has been taken; for, in the case of a meal actually containing poison, and followed by symptoms of poisoning, the articles submitted to analysis may not contain the poison, though some other portion of the meal may. The poison may even be so unequally distributed through a single dish that the part examined may not contain it, though others parts of it do. The poison may be in the gravy, and not in the meat, or it may have been sprinkled only on the outside of the joint. Again, we may fail to detect poison in the contents of the stomach and intestines, because it had been rejected, or evacuated, absorbed, decomposed, or evaporated; or because it belongs to that large class of vegetable poisons which we have not yet found the means of discovering with certainty. Poisons are most likely to be rejected or evacuated when they belong to the class of irritants, absorbed when they are in a fluid state or soluble, decomposed when they belong to the animal or vegetable kingdom. Poisons which are insoluble, or sparingly soluble, such as arsenic, may often be detected in the stomach, and sometimes in the intestines, after repeated vomiting and purging, being glued to the mucous coat by the tenacious products of inflammation.

When the examination of the body is delayed, and in cases of disinterment, we may fail to discover a poison which was in the body at the time of death, from its having exuded through the textures, evaporated, or been decomposed. This observation does not apply to mineral poisons; for though subject to change by the decay of the textures, they are transformed, not destroyed. Thus arsenious acid may be converted into the yellow sulphide; and corrosive sublimate may be changed into the black sulphide of mercury, or to calomel, by contact with the mucous membrane, or it may deposit finely divided mercury. Among animal poisons, cantharides, and, among vegetable poisons, strychnia, may be mentioned as undergoing little change from the decay of the textures.

It is scarcely necessary to add that malicious or mistaken imputations of poisoning may be shown to be unfounded by the non-discovery of poison in the matters alleged to contain it.

When poison is found *in very small quantity*, the objection is sure to be advanced that it was not sufficient to account for death; but the objection is met by the obvious reply that the quantity found must needs fall short of that actually taken: for

it is always only a part of the matters vomited or otherwise expelled from the body, of the contents of the alimentary canal after death, or of the blood, tissues, or viscera of the body, which is submitted to analysis; and the quantity found in the stomach is only the surplus of what may have been sufficient to cause death by absorption. The discovery, therefore, of a quantity of poison insufficient to destroy life is scarcely even a presumption that the substance was not administered in a poisonous dose; though it is consistent with the supposition that it had been given as a medicine.

But the value of chemical analysis as evidence of poisoning is not limited to the discovery of a poison in some single substance; for by comparing one analysis with another, important light may be thrown on the mode of administration, and the innocence or guilt of a suspected or accused party. A bowl of porridge eaten at breakfast by a female believed to have died poisoned, was found to contain arsenic. The chemical analysis showed that the poison was not mixed with the store of meal, but only with the portion used in making the porridge; and as other circumstances justified the inference that the poison had been mixed with the meal in the morning before any stranger entered the house, the husband (the only other inmate) was convicted of the murder. In a case of an opposite kind arsenic was found mixed with a large mass of flour, as well as with the part used in making bread. It was accordingly inferred that the flour had been ground from wheat intended for seed, mixed with arsenic to destroy insects, and sent, in mistake, to the mill.*

In several cases of poisoning by corrosive acids, the clothes of the suspected murderer have been stained in the same way as the clothes and body of his victim.

The cases just referred to are examples of *qualitative* analysis. The value which may sometimes attach to *quantitative* analysis is shown by the two cases which follow.

Mr. Hodgson, a surgeon, was tried at Durham Autumn Assizes, in 1824, for attempting to poison his wife. He had substituted corrosive sublimate for calomel in pills containing opium, prescribed by her physician, but this he attributed to a mistake committed while he was intoxicated. It was also proved that a laudanum draught, ordered by her physician, contained corrosive sublimate; but this, too, he explained by alleging that he had mistaken for the water-bottle an injection of corrosive sublimate previously prepared for a sailor. But on submitting the draught and the injection to chemical analysis, the former was found to

* Cases quoted from Alison and Barrod by Christison. 'On Poisons,' p. 75.

contain fourteen grains, while the latter contained only five grains, to the ounce.*

Samuel Whalley was indicted at York Spring Assizes, in 1821, for administering arsenic to Martha King, who was pregnant by him. But it appeared that, of the tarts in which the arsenic was alleged to have been administered, the portions eaten could not have contained more than ten grains, while the matters alleged to have been vomited, contained, even after repeated attacks of vomiting, fifteen grains.

5. *Conduct of suspected persons.*—Great importance is very properly attached, in trials for poisoning, to the conduct of the prisoner, before, during, and after the illness of the deceased. He is often proved, without adequate motive, to have made a study of poisons and their properties; to have purchased poison under false pretences; to have compounded medicine, or prepared food for the deceased; to have sought opportunities of administering medicine or food; to have made himself the sole attendant on the deceased; to have hastily disposed of matters which might have been examined; to have placed obstacles in the way of obtaining proper medical assistance; to have kept near relatives, and other inconvenient witnesses at a distance; to have made hurried arrangements for the funeral; to have opposed the examination of the body; to have tampered with the matters reserved for analysis. Such acts as these, some of which are likely to fall under the notice of a medical attendant, will have to be carefully weighed by the jury, together with such other items of general or circumstantial evidence as point to the existence of an obvious motive or inducement to the crime, or indicate the previous state of mind of the deceased, as affording a probability, or the reverse, of suicide.

6. *Symptoms and post-mortem appearances proper to the different classes of poisons.*—The foregoing observations will be understood to apply to poisons in general. The symptoms and post-mortem appearances proper to the principal classes of poisons will now be described, both as giving completeness to the present chapter, and as supplying information applicable to the special poisons both of the inorganic and organic divisions. There are two classes of poisons which present both symptoms and post-mortem appearances of a well-defined character—the corrosives and the irritants—and a third class, divided into important subclasses, according as they affect the brain, the spinal cord, the heart, or the lungs, in which the symptoms are well marked, but

* For a full report of this interesting case see the 'Edin. Med. and Surg. Journal,' vol. xxii. p. 438.

the post-mortem appearances less constant, the alimentary canal being subject to like uncertainty of action and post-mortem appearance. This third class formerly comprised the two distinct divisions of narcotics and narcotico-acrids. These several classes will now be briefly passed under review.

a. Corrosives.—This class of poisons is characterised, as the name implies, by their destructive action on the parts with which they come in contact. If they were to act on a large extent of the cutaneous surface, they would destroy life as burns and scalds of like extent and severity. When swallowed, they prove fatal by the same destructive action on the lining membrane of the alimentary canal, or of the windpipe, the immediate causes of death being shock, exhaustion, perforation of the stomach or intestines, starvation from stricture of the gullet, or extensive destruction of the secreting membrane of the stomach, and in rare cases occurring chiefly in young children, suffocation from injury to the glottis and windpipe. These effects are produced, among inorganic poisons, by the mineral acids and the caustic alkalies and their carbonates, among the organic poisons by strong solutions of oxalic acid, and of tartaric and citric acids. In the group of inorganic poisons there are also several corrosive soluble salts (chlorides) of the metals mercury, antimony, zinc, and tin, which combine with their direct corrosive action remote specific effects in addition to those due to the corrosion itself.

The *symptoms* due to these poisons are very well marked. They have a strong acid, alkaline, or metallic taste, and a burning pain, which occurs almost simultaneously in the mouth, throat, gullet, and stomach, whence it extends rapidly to the entire abdomen. This is soon followed by vomiting, and after no long interval by purging. The matters discharged contain blood, either pure, or acted on by the poison. The epiglottis and upper part of the windpipe are often so corroded as to occasion suffocation and speedy death.

The *post-mortem appearances* are those of corrosion, mixed with corrugation from strong contraction of the muscular fibres, and followed by inflammation and its consequences. The corrosions may be confined to small spots, or may extend over a large surface; may be limited to a removal of portions, more or less considerable, of the lining membrane of the gullet and stomach, or may destroy all their coats, so as to occasion perforations large or small, and the discharge of considerable portions of the organs themselves (as well as of casts of them resulting from the action of the acids on their secretions) by vomiting or by stool. Beyond the corroded parts, the textures are acutely inflamed, sometimes

gangrenous, often black from blood extravasated into the cellular tissue beneath, or injection of the vessels with dark blood. Sometimes the tissues are found softened, sometimes hardened and shrivelled. These poisons often produce in the gullet a peculiar wrinkled and worm-eaten appearance, due to the contraction of the longitudinal and transverse fibres, and the removal of patches of epithelium. (See figs. 72, 73, and 74, p. 428.)

As these effects of the corrosive poisons may possibly be mistaken for post-mortem appearances due to other causes, it may be well to point out more particularly the characters by which the one may be distinguished from the other.

Softening of the mucous membrane due to the corrosives is attended by changes of colour arising, in the case of the mineral acids, from their direct action on the tissues, in the case of corrosive sublimate, from the deposit of the finely divided metal or its sulphide. In the case of some other corrosive poisons we are not assisted by these changes, but must be guided by the state of the gullet, and the action on the skin and clothes. The *hardened and crimped* state of the parts with which the corrosive comes in contact is eminently characteristic; it is never present in disease. The black injection of the vessels is not conclusive, for it may be produced by the action of any acid liquid or acid secretion of the stomach itself. *Gangrene* is a rare result of disease, and the black infiltration into the submucous tissue for which it is sometimes mistaken is equally uncommon. *Ulceration* and consequent *perforation*, the result of the action of the corrosives, is to be distinguished, in the case of most of them, by characteristic colours; and this is true both of small ulcers and of extensive destruction of the tissues. The characters of ulcers from disease will be presently described, when speaking of irritant poisons. That extensive destruction of the coats that sometimes arises from the action of the gastric juice after death belongs to this place.

The destructive action of the gastric juice after death was formerly a subject of controversy; but the fact of its sometimes taking place has been placed beyond a doubt, by observations in man and experiments on animals. The usual seat of the opening is the posterior part of the stomach, but it varies with the position of the body. The aperture may be as small as a shilling or as large as the palm of the hand: and it has even been found to occupy one-half of the stomach. It may assume any shape; its edges are fringed, softened, and smeared with a dark pulpy mass; and the vessels of the stomach are often found injected with dark blood—a common action, as already stated, of acid fluids. The

neighbouring viscera sometimes undergo a similar change. Occasionally there is more than one aperture. As there is no inflammation around the opening, it is not possible to confound this post-mortem change with the effect of an irritant poison, which would be attended by marks of acute inflammation, and by characteristic stains and deposits. When the gastric juice acts only on the mucous membrane of the stomach it gives it a soft gelatinous appearance of a black or dark brown colour.

Perforation of the *intestines* is very rare in cases of irritant poisoning, and perforation of the *gullet* still less common. Both may occur from diseases not difficult to recognise after death.

b. Irritant Poisons.—Substances that inflame the parts to which they are applied are said to act as irritants to those parts; and those which produce the same effect on the alimentary canal are also termed irritants; and, with the exceptions indicated when defining the term *poison*, of hot and cold water, and such articles as pins, needles, and powdered glass, may claim to be admitted into the list of irritant poisons, if they prove in any instance fatal to life, or productive of symptoms of great severity.

The class of irritants comprises mineral, animal, and vegetable substances; it contains a greater number of individual poisons than all the remaining classes put together; and it also contributes largely to the list of cases of poisoning. It accounts for nearly one-fourth (63 in 268) of the annual deaths from ascertained poisons; of which the great majority (61 in 90) were metallic irritants.

Of this considerable class two groups admit of distinction and separation; one, the members of which destroy life by the irritation they set up in the parts to which they are applied; the other, by adding to local irritation peculiar or specific remote effects. To the first group belong the principal vegetable irritants, some of the alkaline salts used in medicine, the less active metallic poisons, some products of destructive distillation, and the irritant gases. The second group comprises the metallic irritants, arsenic, mercury, antimony, lead and copper; the metalloidal elements, phosphorus, and iodine; and one product of the animal kingdom, cantharides.

The *symptoms* caused by irritant poisons, as a class, are burning pain and constriction in the throat and gullet; sharp pain, increased by pressure, in the pit of the stomach; intense thirst; nausea and vomiting, followed by pain, tension and tenderness of the entire abdomen, and purging attended with tenesmus, and frequently with dysuria. The constitutional symptoms vary with

the intensity of the irritation, and the interval which has elapsed since the administration of the poison, being at one time those of collapse, at another of inflammatory fever. The mode of death also varies. One patient will not rally from the first shock to the nervous system; a second dies in strong convulsions; a third worn out by protracted suffering; a fourth starved through the permanent injury inflicted on the gullet and stomach.

These symptoms vary in severity, and in the time and order of their occurrence, with the quantity of the poison, its solubility, and the full or empty state of the stomach. When the poison is sparingly soluble, as is the case with arsenious acid, the pain and sense of constriction in the throat and gullet are not felt immediately on swallowing it, but after an interval more or less considerable, and, occasionally, they are absent; or they follow the other symptoms instead of preceding them, in consequence of frequent acts of vomiting, and the repeated contact of the dissolved or suspended poison with the upper portions of the tube. The stronger and more soluble irritant poisons cause the discharges from the stomach and bowels to be mixed with blood, which happens rarely, and to a more limited extent, in the case of the simple irritants; and they sometimes inflame the upper part of the windpipe, giving rise to hoarseness, wheezing respiration, and harassing cough, occasionally ending in suffocation.

The post-mortem appearances caused by the irritants are those of inflammation and its consequences.

The simple irritants give rise to inflammation more or less severe, followed by its usual consequences. In some cases there is merely increased vascularity, in others deep redness; and the surface may be coated with a tenacious secretion, and the cavity filled with a glairy mucus. The coats may be found thickened through the intensity of the inflammation; black from bloody extravasation into the submucous tissue; ulcerated, gangrenous, and sloughing; softened; but occasionally hard and shrivelled. Vessels filled with dark blood are sometimes found ramifying minutely over the surface, which in other instances is studded with black points. These appearances are not confined to the stomach, but are found in the fauces, and gullet, and in the duodenum. The rest of the small intestines is often the seat of acute inflammation, with ulceration and softening of the mucous membrane; ulcers are also found in the large intestines, and excoriation of the anus. In some cases the lining membrane of the larynx and air passages is inflamed.

Several of these symptoms and post-mortem appearances are not peculiar to poisoning; they may be present in English and

Asiatic cholera, in acute inflammation of the stomach or bowels, in rupture of these parts, or of other viscera of the abdomen. They may also be produced by drinking hot or cold water; and authors have been at some pains to show that simple distension of the stomach, vomiting and purging of blood, colic, strangulated hernia, obstruction of the bowels, diarrhœa, and dysentery, have some symptoms in common with ordinary cases of irritant poisoning, and may still more nearly resemble certain exceptional cases. Though some of the objections founded on this possible resemblance of disease to poisoning are of little force, it may be well to point out some leading features in which the diseases in question differ from the usual effects of irritant poisons.

In *English cholera*, the evacuations very rarely contain blood, and there is no pain and constriction in the throat, though there may be some soreness as the result of constant efforts to vomit. The disease prevails chiefly in summer and autumn, and is rarely fatal. In *Asiatic cholera*, too, discharge of blood is a very rare occurrence, though the evacuations sometimes have a port-wine tint; and the pain and constriction of the throat are wanting. In both diseases the purging follows the vomiting much more rapidly than in cases of poisoning. There is one group of cases of poisoning by arsenic, in which the symptoms so nearly resemble those of the two forms of cholera, that medical men have fallen into error without seriously affecting their reputation. *Acute inflammation of the stomach*, except as the result of drinking hot or cold water, or as the effect of some irritant substance not esteemed poisonous, is very rare, and is not attended by pain and constriction of the throat, or by diarrhœa. *Acute inflammation of the bowels* affects their peritoneal covering, and is attended with constipation. *Distension of the stomach*, though an occasional cause of severe suffering and of sudden death, does not admit of being mistaken for the effect of a class of poisons of which vomiting is a leading symptom. Indeed, a full stomach is in itself the strongest possible presumption against irritant poisoning. *Rupture of the stomach* occurring, as it often does, during or directly after a meal, and through an effort to vomit, followed by sudden and violent pain, by collapse, and by death instantly, or in from four or five to less than twenty-four hours, might naturally raise a suspicion of poisoning, which nothing short of a post-mortem examination could set at rest. The same observation applies to rupture of the inner coat alone (a very rare occurrence) and to *rupture of the intestines or other viscera of the abdomen*, all which accidents may be followed by vomiting,

with excruciating pain, and extreme tenderness of the abdomen, cold skin, feeble pulse, and symptoms of collapse, with death within twenty-four hours. The effect of drinking *hot water* differs from that of the simple corrosives, chiefly in the absence of characteristic stains, and the negative result of an analysis. The drinking of *cold liquids* sometimes causes vomiting and purging, and other symptoms allied to those of irritant poisoning; and, in the absence of a complete history of the case, we may have to resort to the negative evidence afforded by the result of an analysis.

Of *vomiting and purging of blood* it will be sufficient to remark that they are not accompanied by urgent symptoms suggestive of the action of poison; of *diarrhœa* and *dysentery* that, in the great majority of cases of poisoning discharges from the bowels are associated with vomiting; and of *colic, strangulated hernia*, and *obstruction of the bowels*, that they are attended by constipation, and that the vomited matters are often feculent.

The *post-mortem appearances* in irritant poisoning are not always characteristic; and it is true of the more common appearances, as of some of the more usual symptoms, that they may be occasioned by disease. Those usually specified are *Redness, Gangrene and Lividity, Softening, Ulceration, and Perforation of the mucous membrane.*

Redness of the mucous membrane may be produced by colouring matter: but when it is due to blood contained in the vessels, it may be traced to subsidence after death; to repletion of the small vessels by the contraction of large arteries; to transudation through the peritoneal covering of the liver or spleen; to congestion in cases of sudden death, especially if caused by apnœa, when it often occurs in large bright patches; or lastly, it may result from the flow of blood to the stomach which takes place during digestion. Sometimes, too, a remarkable redness of the stomach is found after death without any symptoms having occurred during life to account for it. Hence, mere redness of the mucous coat of the stomach is not to be regarded as a proof of inflammation: but when it is combined with softening, putrefaction not having set in; when the membrane itself is covered with a thick and tenacious mucus; when it is opaque, so that when dissected off it hides the finger over which it is stretched, the redness may certainly be attributed to inflammation; and the same remarks apply to the intestines.

Gangrene and Lividity.—Gangrene of the mucous membrane is a well-known consequence of obstructed circulation in cases of hernia, and of internal constriction, and authors of reputation

have described it as a consequence of acute inflammation; but it is probable that the dark appearance caused by infiltration of blood blackened by acid secretions has been often confounded with it.

Lividity.—When this occurs as a minute injection of the vessels with black blood (figs. 74 and 75, pp. 428 and 429), it may be the result of the action of an acid introduced from without, or generated within the body; and it can be produced after death by pouring any of the mineral acids into the intestines. Lividity then, or blackness, of the membrane, when it is not caused by gangrene, is an appearance not directly due to disease, but the effect of some acid, swallowed or secreted. The blackness sometimes met with in the intestines in acute dysentery and enteritis, if not gangrenous, is probably due to the same cause. The deposit of black pigment known as melanosis, is distinguished by being arranged in regular, well-defined spots, without thickening of the membrane, or signs of surrounding inflammation.

Softening.—The mucous membrane may be softened or hardened by the action of poisons, or as the result of inflammation caused by them, or it results from disease. But it is a very common effect of the action of the gastric juice after death. As that occasioned by the non-corrosive irritants is attended by marks of acute inflammation, the true cause will be readily recognised; and the fact that morbid softening is not preceded by any characteristic symptoms will greatly assist the diagnosis.

Ulceration.—Ulcers of the stomach may arise from disease, or from the action of poison. The former are the result of cancer of the stomach, which is readily recognised, or they occur in stomachs which, in other parts, present a healthy appearance. Open ulcers, or the scars of ulcers, are present in about one dead body in ten, and in about one-fifth of the cases there is more than one ulcer. The ulcer is rarely much smaller than a fourpenny piece, or larger than a crown, but it may attain a diameter of five or six inches. It is usually round or oval; and presents the appearance of a shallow but level pit, with a sharp, smooth, vertical edge, as though it had been punched out; and as the opening in the submucous areolar tissue is smaller, and the aperture in the peritoneum, if the ulcer perforates, still more minute, it has the appearance of a cone, with the base directed inwards. The mucous membrane and the areolar tissue are somewhat thickened by exudation of lymph, and it is not unusual to find adhesions to surrounding parts. In some cases there is little or no appearance of inflammation around the ulcer; in most the edges are thickened and raised, and the thickening may extend

to a circle of half an inch or an inch; and sometimes the surrounding parts are described as "a thick brawny mass," or as being blackened. These appearances have been mistaken for cancer. More than a third of the ulcers occupy the posterior surface of the stomach, and more than three-fourths either that part, the lesser curvature, or the neighbourhood of the pylorus. The ulcers caused by poisoning are the result of a more intense inflammation; and they are often found discoloured, as in the case of poisoning by nitric acid and iodine; or covered with a white powder, as in the case of poisoning by arsenic; or coated with the decomposed poison, such as the black powder (minutely divided mercury), formed by the decomposition of corrosive sublimate, or the yellow sulphide of arsenic formed during the process of putrefaction after death.

Perforation of the Stomach may arise, from 1, Corrosion; 2, Inflammation, followed by ulceration; 3, Softening during life; and 4, The action of the gastric juice after death.

1. *Perforation from Corrosion.*—It is impossible, as already stated, to confound a perforation due to the direct *corrosive* action of an irritant poison with any perforation arising from natural causes acting either during life or after death. The state of the mouth, throat, and gullet, and often of the skin and clothes of the deceased, renders the distinction easy; and in many cases the contents of the stomach or bowels escape into the cavity of the abdomen, and leave traces of their action on other viscera.

2. *Perforation from Ulceration* is very rare. When caused by idiopathic inflammation, the surrounding mucous membrane is less highly inflamed, and neither stained nor covered with deposit, as in poisoning by the irritants.

3. *Perforation from Softening* of the coats of the stomach during life is not a rare occurrence. It most frequently happens in young females, from fifteen to twenty-five years of age, and often after slight symptoms of indisposition. The rupture generally takes place soon after a meal, more rarely as a consequence of sudden exertion, and it is instantly followed by sharp pain of the abdomen, and symptoms of acute inflammation of the peritoneum. There is little vomiting, and no purging, but the patient dies in a state of collapse in from eighteen to thirty-six hours; but in some cases, when the stomach is nearly empty, the fatal event is postponed, so that the inflammation is of limited extent, or subacute in character. The opening in the peritoneum is generally small, and the ulcer has the peculiar characters just described. In one-third of the cases the perforation has been in the lesser curvature; in one-tenth at the pyloric extremity; in about one-

twentieth on the posterior surface; in the same number, at the cardiac extremity; while in one-eighth of the cases two ulcers have been found opposite each other on the anterior and posterior surfaces of the organ, the first being the seat of the perforation.* The absence of marks of acute inflammation, and of characteristic discolorations; the non-detection of poison in the stomach, or in the contents of the abdomen; the sudden occurrence of pain in the belly as the first symptom; the slight vomiting; and the absence of diarrhœa, distinguish this form of perforation from that due to poison.

4. The destruction, and consequent *perforation caused by the gastric juice after death*, has already been spoken of at p. 377.

The poisons which are neither corrosives nor irritants, or which, if they act in either of these ways, prove fatal by their effect on the nervous centres, and, through them, on the brain, heart, or lungs, were formerly comprised under the two heads of *narcotics* and *narcotico-acrids*, oxalic acid (a corrosive in strong solution) being the principal exception. These two classes are now more conveniently treated in different sections according as their most obvious and striking symptoms, when given in full doses and acting in their usual manner, are those of the brain, spinal cord, heart, or lungs. These will be designated, for the sake of convenience, as affecting the *brain*, *spinal cord*, *heart*, and *lungs* respectively. It may be well to repeat that this arrangement is based on some notable prevailing symptom or group of symptoms, not on the precise *modus operandi*, or proximate and real cause of death.

1. The poisons which affect the *brain* may be distributed into three leading sub-classes: one group, of which *opium* is the type, causing sleep more or less profound; a second, of which *belladonna* is the type, producing delirium, with illusions; and a third, of which *alcohol* is the type, giving rise to exhilaration followed by delirium or sleep, or both successively or alternately, according to the dose and the constitution of the individual.

The group of poisons of which opium is the most conspicuous member owes its importance less to the number of individuals which it comprises (for they are few), than to the habitual use made of them by large classes of persons, their constant employment in the treatment of medical and surgical maladies, the many accidents to which they give rise, and the many occasions on which they are employed by the suicide and murderer. Opium

* Consult Brinton 'On the Pathology, Symptoms, and Treatment of Ulcer of the Stomach;' and Taylor's Essay in 'Guy's Hospital Reports,' No. 8.

and its preparations alone are taken in nearly half the cases in which the poison can be identified.

The poisons of this sub-class present difficulties which do not occur in the case of irritants. Their symptoms more nearly resemble those of disease, and the post-mortem appearances are often very indistinct, and, even when best marked, not highly characteristic. The chemical analysis also is less sure and satisfactory than in the case of irritant poisoning. The *symptoms* proper to this class are giddiness, headache, dimness of sight, extreme contraction of the pupil, noises in the ears, drowsiness and confusion of mind, passing into insensibility more or less complete. Delirium is rare, and paralysis, convulsions, and tetanic spasms only of occasional occurrence. There is no direct irritation of the stomach and bowels, but nausea and vomiting may occur, not at the commencement (as in the case of irritants), but when the patient begins to recover. Diarrhœa, also, is a rare incident. The *post-mortem appearances* consist in fulness of the veins and sinuses of the brain, effusion of serum beneath the membranes, at the base, or into the ventricles; and, in a few cases, extravasation of blood.

There are several diseases of the nervous centres which, in common with opium and its preparations, have coma more or less profound, and insensibility more or less complete, as prominent symptoms. Apoplexy, cerebral effusion and turgescence, hydrocephalus, blows and injuries of the head, febrile affections in certain stages, uræmia, the close of an epileptic fit, exposure to extreme cold, and many poisons in certain stages of their action, are attended by a profound sleep, from which the patient is not easily roused, or even with coma and insensibility. The diagnosis of disease and poisoning during life will, therefore, sometimes be difficult, especially in infants and young children; and after death the appearances of the brain may prove inconclusive. The discovery of disease of the kidney would furnish a probability of uræmia, and inflammation or chronic disease of the brain, or any considerable collection of serum upon or within it, would supply a sufficient explanation of death.

The sub-class of poisons, of which belladonna is the best example, is strongly characterized by delirium, spectral illusions, and a largely dilated pupil, with dryness of mouth and throat, and thirst, without any characteristic post-mortem appearance. Tetanic spasms, heightened sensibility, paralysis of the motor and sensitive nerves, coma, and insensibility, are among the exceptional symptoms. But great difference in degree, and strange varieties in the com-

of poisoning are occasioned by many differ-
causes.

The diagnosis of poisoning and disea
rarely present any difficulty. The poiso
active properties each to one well-defined
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of leaves, berries, seeds, or root; and th
may often be identified in the contents
rejected during life or found there after
irritation is added to the other sympton
matters, and not to these active principl

The third sub-class of poisons, of whi
characterised rather by the succession
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circulation and of the cerebral function
weakness, shown by want of power as
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found sleep, coma, and insensibility, con
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lency, and excitement culminating in n
uncommon.

The more chronic form of poisoning
terized by tremor, delirium, and illusions,
of the disease known as *delirium tremen*

It should be borne in mind that the
may show themselves as a result of th
and that they are sometimes present in
mental disorders. In the diagnosis of

shock, or by syncope or collapse less rapidly induced. The first division comprises hydrocyanic acid and the substances that contain it, and oxalic acid and its salts. The second embraces aconite, digitalis, tobacco, lobelia inflata, and hemlock, and some poisons of less importance. A knowledge of their characteristic symptoms may be important in cases of sudden and speedy death. In the case of hydrocyanic acid we are happily greatly assisted by its characteristic odour; in poisoning by oxalic acid by its corrosive action on the gullet and stomach; and in that of aconite by its peculiar effect on the lips, tongue, and palate.

4. The poisons which act on the lungs, and so destroy life, have for their type carbonic-acid gas, which occasions the symptoms and post-mortem appearances present in death by apnœa, however brought about. The operation of this class may have to be distinguished from apnœa produced by other causes; and it should be well understood that in poisoning by many of the more active poisons, and notably by prussic acid in doses short of a quickly fatal one, life may be destroyed by a remote action on the lungs producing fatal apnœa.

CHAPTER III.

METHODS OF PROCEDURE IN CASES OF POISONING.

THE facts and discussions of the preceding chapter have prepared the way for a more direct examination of the duties that devolve on the medical man in cases of alleged poisoning.

Suspicion of poisoning may arise under very different circumstances. It may spring up in the minds of persons ignorant of the nature and action of poisons, suggested by some severe illness, or sudden or speedy death, coupled with the suspicious conduct of some relative or friend; or it may occur to the medical man himself during his attendance on a patient; or, again, it may be the utterly groundless fancy of a person of unsound mind, such fancy constituting the leading features of his malady, or one only of his many delusions. But, in whatever way the medical man may be brought to entertain and consider a suspicion of poisoning, it must be an advantage to him to be reminded of the points to which his attention should be directed. The following is a summary of the leading circumstances to be attended to, and noted down:—

1. The state of the patient before the commencement of the symptoms, whether in good health or suffering from illness—the time at which the symptoms began, and at what interval after a meal, or after taking food, drink, or medicine—their nature, and order, and time of occurrence, and the period of the commencement of any new symptom or train of symptoms; whether they increased steadily in severity, or alternated with intervals of ease, and whether the exacerbations corresponded with a repetition of food or medicine, or followed the use of any new article of food or medicine—also the character of any substances which may have been rejected from the stomach, or passed from the bowels. The exact time of the death should be noted down, and if the person is found dead, the time when he was last seen alive.

2. If the symptoms of poisoning showed themselves soon after a meal, minute inquiries should be made as to the cooking the

several dishes; the vessels used in the preparation of the food should be inspected, and their contents, if necessary, preserved; suspicious powders or liquids found in the house should also be sealed and kept. If several persons have partaken of the same meal, care should be taken to ascertain what articles were taken by those who suffered, and by those who escaped, and in what quantities, and whether the same articles of food had been previously taken without bad effect by the persons attacked.

3. The vomited matters must be carefully collected, and removed from clothing, furniture, &c., on which they had been rejected; and portions of the dress, furniture, or flooring may, if necessary, be reserved for examination.

But suspicions of poisoning may first occur to the medical man during the performance of a post-mortem examination, or he may be required to make such an examination in consequence of suspicions having already arisen in the minds of relatives, or in the course of an inquiry in the coroner's court. In certain cases, too, he may be required to conduct at the same time the disinterment and the post-mortem examination of a body supposed to contain poison. Hence the importance to the medical man of being furnished with a like summary of rules and suggestions to guide him in this important and responsible duty.

Having observed the precautions insisted on at p. 237 as common to all post-mortem examinations for legal purposes, certain other precautions proper to cases of suspected poisoning will have to be taken. These arise out of the fact that while poisons themselves, as well as their most notable effects, are found in the alimentary canal, they, and certain of their secondary effects, are to be sought after in the organs and tissues into which they are carried by the blood. The alimentary canal and the principal viscera or parts of them, and, in some cases, blood, or portions of muscle, will have to be preserved for the minute examination and chemical research of the person making the inspection, or of some skilful chemist to whom they must be forwarded.

Prior to the inspection, one large wide-mouthed jar, of glass or earthenware, and a few smaller ones, should be got ready, which, if not new, should be repeatedly washed out with water and drained, so as to be quite clean. They should be furnished with clean ground-glass stoppers, or with new corks, or other non-metallic means of closure. The larger jar is for the intestinal canal and its contents, the smaller for the other viscera, or parts of them. The method of procedure, as far as it relates to the intestinal canal, must be governed by such considerations as the

following:—When the poison is a corrosive its effects are to be looked for chiefly in the mouth, tongue, throat, windpipe, gullet, stomach, and upper part of the small intestines, and, in case of perforation, in the contents of the peritoneum. But if the poison is one of those irritants which combine local action with remote specific effects, we may find marks of its direct action on the gullet, stomach, small intestines, and even on the whole intestinal canal; while the viscera to which it is carried by the circulation may also become inflamed, and especially those engaged in the work of elimination, such as the kidneys and urinary organs, and the glands of the large intestines. In poisoning by alcohol, chloroform, hydrocyanic acid, opium, and the alkaloids, the local effects may be limited to the stomach and upper part of the intestines, but the poisons first named may be found in the serum of the brain. Lastly, animal or vegetable poisons taken in substance, whether as leaves, roots, fruit, or seeds, or as powder, may be found in any part of the alimentary canal. Considerations such as these will determine the parts to be examined, as well as those which ought to be reserved for further examination and analysis. In every case, the whole length of the intestinal canal should be carefully inspected, and especially the gullet, stomach, and upper part of the small intestines, the cæcum, and the rectum; and these parts with their contents, subject to exceptions arising out of the foregoing considerations, should be reserved. The examination on the spot must be so conducted as not to interfere with the more minute examination and chemical analysis afterwards to be made. Accordingly the stomach should be first secured by ligatures at the lower end of the gullet and upper end of the duodenum, and then drawn out and placed in a large clean plate or chemical dish. It should then be slit up from end to end in the line of the lesser curvature, its contents inspected and emptied into one of the jars, the inner surface of the organ itself carefully examined, and the ligatures removed. Double ligatures should then be applied to those points of the gullet and small intestines which present characteristic appearances. The stomach and the parts thus selected are then to be placed in one of the jars. The cæcum, with some inches of the lower part of the small and upper part of the large intestines, should be treated in the same way, as well as such other parts of the canal as are inflamed, or contain matters worth examining. In the case of the corrosive poisons and stronger irritants, the gullet, with the upper part of the windpipe and the tongue attached, will have to be removed and secured. Of the other viscera, the liver (or part of it), as the organ to which poisons are first carried by

the circulation, the kidney as an active organ of elimination, the contents of the urinary bladder, the heart, as a muscular structure rich in blood, and portions of blood, should be reserved; and in cases just indicated the serum of the brain and parts of the organ itself.

The organs and their contents thus reserved for further examination having been placed in separate jars, these must be securely closed by stopper or cork, covered with leather or stout paper firmly fastened round the neck, no sealing-wax, metal, or substance containing metal, being used. Tickets should then be attached, with numbers corresponding to those used in a description dictated at the time of the inspection, and verified immediately afterwards. The several jars should be carefully packed, and the parcel secured by seals. Letters of advice forwarded by post, and all other communications relating to medico-legal examinations in progress, should be doubly secured, first by wafer or gum, and then by seal; and should, if possible, be posted by the writer; all other correspondence being carefully avoided.

That these minute precautions are not unnecessary may be inferred from a fact reported by Tardieu and Roussin. Oxide and carbonate of copper were found on the mucous membrane of the stomach, in consequence of a large pin having fallen into it after the autopsy.

In cases of exhumation, the character of the soil, the mode of interment, the state of the grave, the condition of the coffin and of the grave-clothes, as well as the position and appearance of the body itself, should be noted, and, if the earth is anywhere in contact with the corpse, a few pounds of it might have to be reserved for analysis. If the interment has taken place in lead or a close-fitting coffin, and the body happens to adhere firmly to its sides, the inspection should, if possible, be made without removing it.

The viscera and their contents having been carefully removed from the jars that contain them, care being taken to preserve their identity, will have to be submitted to two successive examinations, the one *physical* the other *chemical*.

The *physical examination* will be directed especially to the stomach and intestines, and the matters adhering to their inner surface. Having noted the odour of the contents of the stomach as indicative of the presence of alcohol, phosphorus, hydrocyanic acid, opium and its preparations, sulphuretted hydrogen (as given off from the sulphide of potassium), and a few poisons less commonly employed; and, if in doubt as to the existence of any characteristic odour, warming the organic matters to a temperature not exceeding 100° Fahr.; each part of the

intestinal canal should be in turn spread out on a clean sheet of window-glass, with the internal surface outwards. The entire surface should then be searched by transmitted and reflected light, first with the naked eye, then with a large hand-lens; its appearance described, and any substances that may happen to attract notice by their form or colour particularly examined. Such small portions of the organ as present the most marked appearances may then be cut out, spread on clean glass slides, and examined under the microscope. By this means we may ascertain the kind of food that has been recently taken, whether it consisted of, or comprised, animal matters revealed by muscular fibres; or adipose tissue, with its polyhedric cells and fat globules wholly soluble in ether; or vegetable matters, with their spiral vessels, stomata of leaves, and chlorophyl soluble in alcohol, and imparting to it its own colour; sometimes also characteristic woody fibre. Or we may find evidence of a particular kind of farinaceous food in the characteristic starch granules of wheat, potato, rice, maize, or Indian corn flour, oatmeal or arrowroot, or the spores of mushrooms.*

We may also find more or less firmly attached to the mucous membrane certain white powders, as magnesia or its carbonate, or the bicarbonate of soda taken with a meal or after it, or calomel taken as medicine, or arsenious acid given as a poison, and possibly undissolved corrosive sublimate, or imperfectly dissolved crystals, say of oxalic acid.

We may also recognise the corrosive action and characteristic discolorations of the mineral acids, and, when the stomach is far advanced in putrefaction, the sulphides of the metals (arsenic yellow, antimony orange, mercury black) or finely divided mercury as a dark gray coating; as also the green aceto-arsenite of copper, the shining green and gold specks of cantharides, the brown powder of nux vomica, the blue of Battle's vermin killer; and, as seen in the dark, the phosphorescent light of phosphorus.

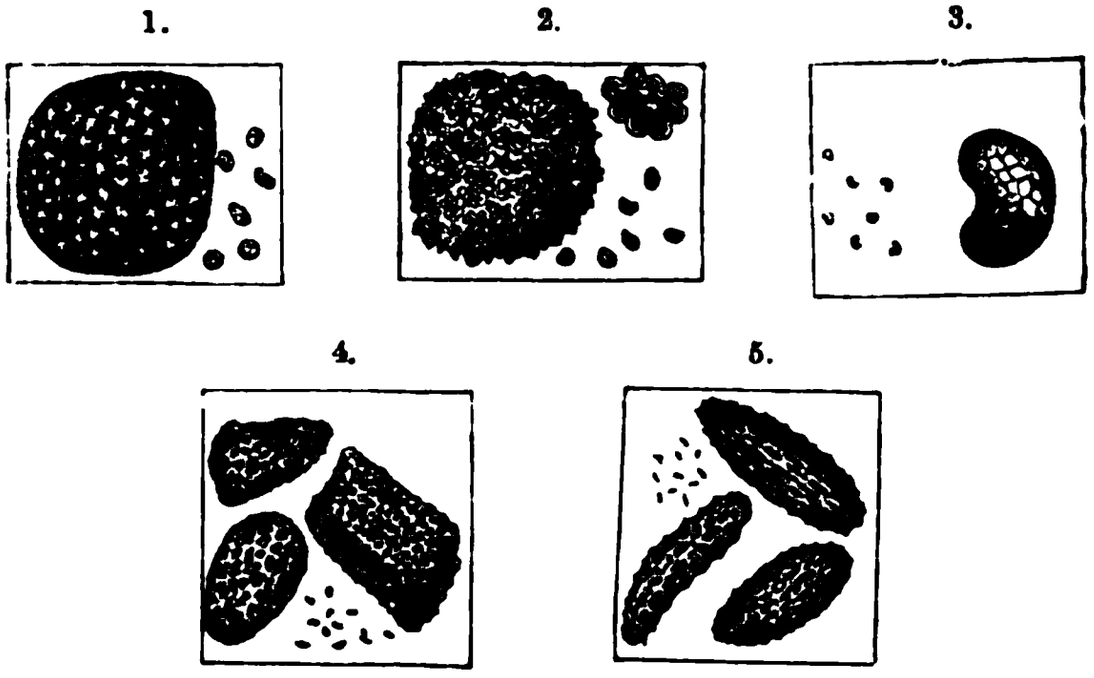
The colour and consistence of the contents of the stomach will afford important indications. The black, dark brown, or greenish brown grumous matter resulting from the action of the mineral acids and oxalic acid on the blood, food, and tissues; and the green matter resulting from the eating of green leaves from the hedges are also characteristic: and sometimes we may find fragments of leaves large enough for identification.

When the fruits of poisonous plants are eaten by children we may find in the stomach or intestines the seeds which they con-

* For the characteristic forms referred to in the text, consult the 'Micrographic Dictionary' of Griffith and Henfrey.

tain. Those of the plants which require the microscope for their identification are shown in the annexed figure, in which—1. Shows the seed of Belladonna; 2. That of Hyoscyamus; 3. That of the Papaver somniferum; 4. That of Digitalis; and 5. That of the Lobelia inflata.

Fig. 42.



Portions of the larger poisonous seeds, such as stramonium, colchicum, aconite, castor, and croton, may also be identified by the colour and markings of their cuticles.

The advantage that may accrue from a thorough examination of the contents of the stomach is well shown by a case given by Tardieu. A child twelve years old died at school after ten hours of acute suffering on the day on which its stepmother had brought it several good things to eat. Among the contents of the stomach there were found certain fragments of crumb and crust of bread, which, when examined by the microscope, were found covered with fungous growth, showing that the bread was mouldy. Arsenious acid, in powder, was also found in large quantity. The fact of the mouldy bread was noted down, but no importance seemed to attach to it, till, at the trial, one of the witnesses, a servant of the stepmother, stated that her mistress was in the habit of carrying to the child slices of bread and jam, but that on the day of the death she said that she would not take it, because the bread was mouldy. It had been in that state for one or two days.

Having indicated the precautions to be taken in searching the

portions of the alimentary canal reserved with their respective contents for chemical examination, a few hints will now be offered (as reminders to those who possess practical experience, and as necessary instruction to the learner) under the distinct headings suggested by the following considerations.

The poisonous substances submitted to the chemist for examination may be in their pure unmixed form, whether solid or liquid, often in large quantities; or they may be small remnants of powder or crystal adhering to papers from which they were taken, or to cups or glasses out of which they were swallowed. In other instances the poison is dissolved in some common beverage, as beer, brandy, rum, tea, or coffee. In other cases, again, it has to be sought for in the urine; or in the serum of a blistered surface, or of a serous sac after death; or lastly, it may be contained in mixed articles of food of some consistence, spilled in the act of swallowing, voided during life from the stomach and bowels, or found in them after death; or in such thick viscid matters as the blood; or even in the solid structures of the body.

Cases in which the poison exists in a pure state and in large quantity may be disregarded for the present, as belonging rather to the domain of chemistry than of toxicology, attention being given to the detection and identification of such minute quantities as are extracted from the body itself as ultimate results of long and complicated processes of analysis. The methods of dealing with the minute quantities so obtained are, however, equally applicable to all the more delicate operations of toxicology; so that one division of our subject will be usefully devoted to a description of those methods. Another division will comprise those methods by which we succeed in reducing thick mixed organic liquids, or the solid textures, to a state to pass the filter and become amenable to chemical tests. A third division should treat of the method of procedure in those rare cases in which an organic liquid is presented to the chemist for analysis in the belief that it contains some poison, but in ignorance of what that poison is.

The subject of CHEMICAL PROCEDURES will therefore be treated under the following distinct heads:—1. The methods of obtaining a clear liquid from an organic mixture or substance. 2. The method of procedure when the poison contained in an organic mixture or substance is wholly unknown. 3. The methods of detecting and identifying minute quantities of poison.

1. There are four methods of obtaining clear solutions—*a*. Simple filtration; *b*. Dialysis; *c*. Filtration following the preliminary coagulation of organic matter; *d*. Filtration following its destruction.

a. Of *filtration*, as commonly practised in the laboratory, it is not necessary to speak; but it may be well to point out that, when we are dealing with small quantities of liquid, we may adopt with advantage a method recommended by Christison. A band of filtering paper is rolled up and bent into the form of a syphon, the short leg of which dips into a watch-glass, or other small vessel containing the poison, and the long leg into a second similar vessel placed beneath it. The paper being moistened with distilled water, will be found to transfer the thinner portion of the mixed liquid from the one vessel to the other.

b. The method of *dialysis* of Graham is founded on the fact that if a mixed liquid consisting of albuminous, gelatinous, caseous, or gummy matters, on the one hand, and crystalline matters, such as arsenious acid, or strychnia, on the other, be poured into a short cylinder fitted with a suitable membrane after the manner of a tambourine, and then floated on the surface of distilled water, the crystalline matter will pass into the water, and the other matters remain behind. The tambourine-like float is called the *dialiser;* the matters which pass through to the distilled water are termed *crystalloids*, and the matters that remain behind *colloids*. The dialysing membrane recommended for the purpose is the *vegetable parchment* of commerce. This simple and ingenious method, possessed as it is of the obvious advantage that it introduces into the organic liquid no impurity, has not realized the expectations that were formed of it. Tardieu, for instance, says of it that its "results have not been so satisfactory as he had wished;" that crystalline matters, such as arsenious acid and strychnia, pass through only in small quantity, and mixed with a proportion of organic matter; that the method fails with the salts of mercury and copper, and that it is only when the quantity of the poison is very large, not combined with the tissues, or become insoluble through putrefaction, that the method allows us to isolate a small portion of it; but that even in this case the chemist can arrive at the same result by other means. This statement, justified as it is by experiments,* may be taken as a fair representation of the truth. It limits the use of the method of dialysis to those cases in which we know that we are dealing with considerable quantities of poison, in which dilution with distilled water would not interfere with our future operations, and in which also the loss of several hours of time is unimportant. If, for instance, a chemist receives a substance for analysis in the after part of the day, he may find it advantageous

* Tardieu. 'Sur L'empoisonnement,' p. 100.

to submit it to dialysis during the night. Assuming then that the method of dialysis will find occasional application, it may be well to indicate one or two simple forms of apparatus suitable for the purpose. For most purposes a common funnel resting on the edge of a tumbler half full of water will suffice. The vegetable parchment, cut and folded as for a common filter, being first soaked in distilled water, is to be applied to the side of the funnel, the matters to be operated on are to be poured into it, and the funnel immersed to nearly the upper edge of the filter. This arrangement is shown in fig. 43. A convenient modification consists of a funnel to the stem of which a glass tube drawn out to a fine point is attached by vulcanized India-rubber controlled by a spring. A filter holds the matter to be dialysed, the funnel itself contains the distilled water, and retains it so long as the spring is in action. when it is loosened the dialysed liquid can be made to fall drop by drop on a glass disk, without waste, be evaporated from time to time, and examined by the microscope, and by chemical tests. Or we may apply the method on a smaller scale, substituting a watch-glass for the tumbler, the dialyser folded as a filter, resting on an extemporized support formed out of a square of stout cardboard truncated at the angles, creased near the four corners, and with a circular hole punched out in the centre. The card bent at right angles at the creased lines becomes a convenient support for the filter, which is supposed to dip to the bottom of the watch-glass filled with water. Again, we may operate on a still smaller scale by resting a piece of vegetable parchment the size of a sixpence on a large drop of distilled water standing on a disk of glass. The piece of parchment moistened in distilled water, and moulded into a small cup by pressure, contains the speck of matter to be operated on, and its crystalloids pass through to the drop of liquid on the glass disk.

Fig. 43.

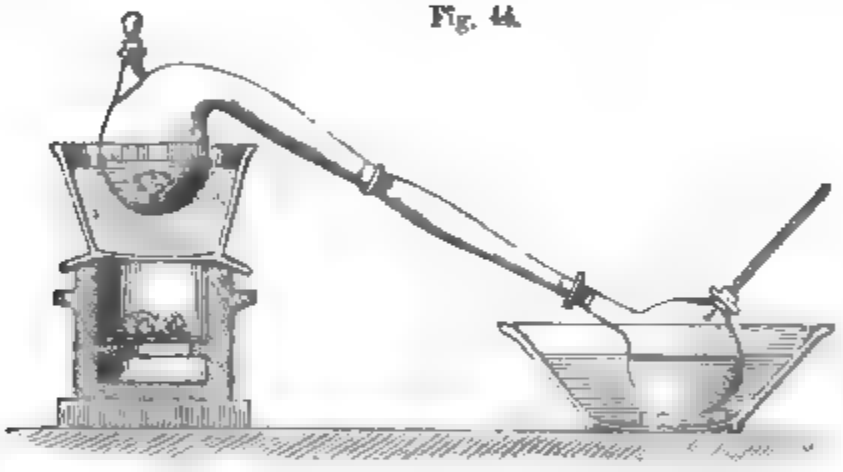
c. Coagulation of organic matter. -This simple method, which also does not introduce any foreign matter into the analysis, might be very largely carried out by heating the organic matters to dryness over a water bath, were it not that some volatile liquid poisons, several of the poisonous alkaloids, and one metallic salt at least, are dissipated by a temperature much below 212°. When, as is the case with most metallic poisons, and some of the most important alkaloids, the subliming temperature exceeds 212°, this simple method may be advantageously adopted. It is also applicable, with like restrictions in respect of poisons which volatilise

under 160°, to serous fluids, and to poisons mixed with grease or tallow.

d. Destruction of Organic Matter.—Several methods have been recommended for this purpose, of which two only need be here described—the first as practised chiefly in France, the second in England.

The first method, as recommended and practised by Tardieu and Roussin, was first proposed by Flandin and Danger. The organic matters brought to the consistence of a soft extract (by evaporation over a water-bath if necessary), are heated with a

Fig. 44.



fourth part of their weight of pure concentrated sulphuric acid in a retort placed over a sand-bath, and attached to a receiver in the manner indicated above. When the acid vapours are no longer given off, the organic matters are found to be reduced to a dry and friable charcoal, which is to be powdered and treated with strong nitric acid. The acid liquor, which holds the inorganic matters in solution, is to be decanted or filtered, and evaporated to dryness. This dry residue is then dissolved in distilled water. This aqueous solution is free from organic matter, and contains all the metals of which the nitrates are soluble in water, blended, however, with the inorganic constituents of the food and animal fluids and tissues themselves—lime, magnesia, alum, iron, soda, hydrochloric and phosphoric acids.

In the second method, the organic matters, cut into small fragments, or reduced to the consistence of a soft extract, are heated for about an hour in a porcelain dish, over a water-bath, with a mixture of one part hydrochloric acid to six water, and chlorate of potash is then stirred into the mixture by degrees till

the solid matters are dissolved and the liquid will pass the filter. It is then filtered, the filter washed several times with distilled water, and the whole liquid, reduced to a convenient bulk, is reserved for examination.

2. METHODS OF PROCEDURE FOR UNKNOWN POISONS.—Here again two methods might be described as procedures of the English and French schools respectively—the first as described by Tardieu and Roussin,* the second by Professor Bloxam.† As the method practised by the first-named authorities is not to be found in an English dress, it is given in this place, the reader being referred for English methods of procedure to the works named below.

The first method is applied to a score of the poisons most in use in France, omitting the corrosive mineral acids as sufficiently revealed by their effects. The first step consists in dividing the organic matters supposed to contain poison into two equal parts, of which the one is to serve for the search after inorganic, the other for the search after organic, poisons. These may be conveniently indicated by the letters *A* and *B*.

A. Search for Inorganic Poisons.—The receiver of the apparatus figured on the previous page is supposed to contain a solution of nitrate of silver. During the first part of the process just described for destroying the organic matters, the vapours that traverse the tube of the retort may be phosphorescent in the dark (*Phosphorus*), or, not being phosphorescent, may cause in the silver solution a white precipitate, insoluble in cold, but soluble in hot nitric acid (*Prussic acid*). Neither of these events having occurred, the distillation is carried on till the organic matters are converted into a carbonaceous mass; this is ground to powder in a porcelain mortar, introduced into an open glass vessel with the tenth of its weight of pure nitric acid, boiled for half an hour, diluted with distilled water, and filtered. To the filtrate, ammonia is added till a white precipitate begins to show itself; sulphuretted hydrogen is then transmitted to saturation, the liquid is allowed to stand twenty-four hours, and if a precipitate appears, it is treated according as it is yellow or black; if yellow, and soluble in ammonia, the poison is *arsenic*; if black, it is collected and washed, and boiled for half an hour with pure nitric acid. The greater part of the acid is thus dissipated, and the residue, dis-

* 'Sur l'empoisonnement,' p. 74 et seq.

† Bowman's 'Medical Chemistry,' edited by Bloxam, p 284. See also Dr. Odling's 'Course of Practical Chemistry,' for very full instructions applicable to the distinction and identification of poisons. Horsley's 'Toxicologist's Guide' treats the same subject in a very condensed form; and Otto's 'Manual of the Detection of Poisons' may be consulted with advantage.

solved in a small quantity of distilled water, is tested as follows:—Dropped on copper foil, it produces a white stain dissipated by heat (*mercury*), or it causes a red stain on an iron plate, which colours ammonia blue (*copper*), or it gives a yellow precipitate with iodide of potassium and a white with sulphate of soda (*lead*). If the sulphuretted hydrogen caused no precipitate, the liquid, evaporated to a tenth of its volume, is introduced into Marsh's apparatus, when, if it yields metallic spots soluble in hypochlorite of soda, it contained *arsenic*. If it yields no metallic spots, recourse is again had to the carbonaceous mass on the filter, which is divided into two parts. The first is boiled for half an hour with a solution of carbonate of soda, and then filtered, the charcoal washed with dilute nitric acid, and the liquids mixed. The acid liquor, evaporated to a convenient quantity, gives with sulphuretted hydrogen a black, and with iodide of potassium a yellow precipitate (*lead*). The second part of the charcoal is boiled with a solution of tartaric acid, and the resulting liquid filtered, and reduced by evaporation. This, tested by Marsh's process, yields metallic stains, soluble in nitric acid, and insoluble in hypochlorite of soda (*antimony*).

B. Search for Organic Poisons.—The apparatus (fig. 44, p. 397) is modified thus:—The beak of the retort is introduced into a porcelain tube, and this into a receiver containing a solution of nitrate of silver, and an arrangement is made for passing a current of air through the apparatus. The organic liquid, brought by fine division of the solid matters to the condition of a thin soup, is poured into the retort, which is heated over a sand-bath, and the vapour transmitted through the porcelain tube heated to redness. If the silver solution shows a white precipitate, soluble in ammonia, and insoluble in boiling nitric acid, the poison was *chloroform*. If no precipitate is formed the contents of the retort are treated by Stas's method, and the resultant of his process, if a strong alkaline liquid, with the odour of tobacco, is *nicotine*: if solid a part of it is introduced into an incision in the thigh of a frog. If it greatly dilates the pupil, and the residue readily dissolves in water, giving a strongly alkaline solution, precipitated brown by iodine, and easily assuming a nauseous odour, it is *atropine*. If the frog is seized with tetanic convulsions, and the residue responds to the well-known colour test, it is *strychnia*. If the frog grows very weak, and has irregular, and intermittent beats of the heart, and if the residue dissolves in warm water, and yields a solution which is not alkaline, but gives a precipitate with tannin, and if the residue itself is coloured green by hydrochloric acid, it is *digitaline*. If the frog presents complex physio-

logical phenomena, and the residue is crystalline, nearly insoluble in water and ether, soluble in caustic potash, and responds to the recognised tests for morphia, it is *opium*.

8. *Detection and Identification of minute quantities of Poison.*—When such minute quantities of poison as the thousandth, ten thousandth, hundred thousandth, or even millionth of a grain are spoken of as easy or possible of detection, inexperienced persons are apt to be incredulous through misapprehension of the bulk of matter which a grain represents.

The best way to correct this misconception is to count the number of distinct visible particles of common objects. I have caused this to be done in the case of certain small seeds, and have found that those of digitalis number 1126 to the grain, and those of lobelia inflata 8176, while the fern seeds of the shops can be counted to the number of 50,900. I have also by successive divisions and subdivisions of a grain of strychnia, the alkaloid being strewn on a surface of black glass, arrived at the $\frac{1}{10000}$th of a grain visible as a bright speck by the naked eye. I have elsewhere shown* that crystals of arsenious acid, weighing as little as the $\frac{1}{3000000}$th of a grain, may be seen and recognised under the microscope. When, therefore, we speak of the ready identification of the thousandth of a grain of arsenic, and the possible recognition of the five thousandth or ten thousandth, we are still speaking of visible particles. When, again, we speak of metallic crusts obtained by Marsh's apparatus, from the half-millionth or millionth of a grain of arsenic, it is only necessary to revert to the fact, that a single grain of gold can be mechanically divided into 490,000 visible pieces; and into the almost incredible number of 4,900,000,000 fragments visible by the microscope.† Of the recognition of minute quantities of matter by other senses, examples are given in the distinct impression on the sense of smell caused by $\frac{1}{300000}$th of sulphuretted hydrogen, $\frac{1}{400000}$th of bromine, $\frac{1}{1200000}$th of oil of resin, and a still less quantity of musk.

Of the methods of detecting such minute quantities of poison as are here spoken of, some are of partial application (Marsh's apparatus to arsenic and antimony, Reinsch's method chiefly to arsenic, mercury, and antimony, the reduction by zinc mainly to lead, tin, and silver, the blow-pipe and borax bead to metals and their salts), others of most extensive use. Of these the *microscope*, the *method of precipitation*, the *method of sublimation*, the *method of liquid reaction on dry spots*, *crystalline forms*, and

* Beale's 'Archives of Medicine,' No. iii. 1858.
† Miller's 'Elements of Chemistry.'

the *spectroscope* may be advantageously described and considered. These will accordingly be treated in the order in which they stand.

1. *The Microscope.*—The necessity of resorting to the microscope in cases of rape and wounds, to identify spermatozoa and blood disks, has long been recognised, but it is only very recently that it has come to play a prominent part in toxicology. But already its applications are very extensive, and promise soon to become still more so. One of its recognised uses is to make a preliminary examination of substances supposed to be poisonous, or to contain poison; another to watch the progress and minute characters of those chemical changes which are known as precipitates, as well as to ascertain the crystalline or other forms which they assume when the chemical reaction is complete; a third to note the crystalline and other forms of sublimates obtained by heat, as well as the effect of reagents upon them. By the ingenious adaptation of the spectroscope to the microscope the utility of the instrument is greatly increased and enlarged. As, in future, it is probable that the microscope will be most largely used in examining the forms of crystals obtained by sublimation, by reactions on sublimates, and by drop-precipitation; and especially in watching the whole course of these chemical changes; it is clear that, for medico-legal purposes, the form of microscope to be commended is that which alone enables us to view these phenomena in their entirety—not only to see the dry result of a sublimation or reaction in full relief, but to appreciate fully all the changes that take place on the surface as well as in the depths of the liquid. All this presupposes the use of a good binocular microscope; and as good light and clear definition is in almost every case far more important than mere enlargement, a good inch object-glass, with a deep eye-piece, will be found to meet all the requirements of the great majority of cases; and this we accordingly recommend with the confidence arising out of a very large experience. (G.) The combination of an inch object-glass, with a No. 1 eye-piece of our best makers, gives a magnifying power of 50 diameters.

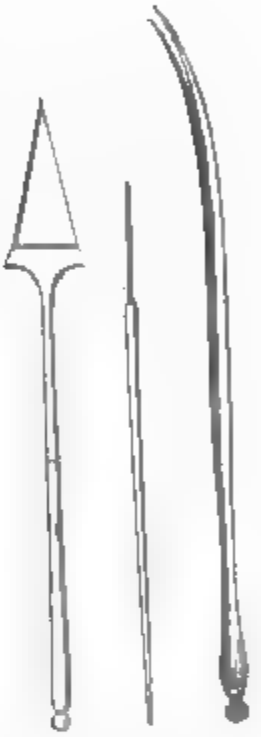
2. *The method of precipitation.*—The method here spoken of is not that which requires the use of the test-tube, but that which is performed under the field of the microscope when a drop of a liquid supposed to contain a poison is treated with another drop of a liquid reagent. It is one that presupposes some delicacy of manipulation, scrupulous cleanliness, and the use of reagents so preserved and applied as to be free from impurity. This latter desideratum is best accomplished by using a form of

bottle which contains a pipette dipping into the liquid, answering the purpose of the glass rod in common use. annexed figure shows the most convenient fo The pipette, drawn to a fine point at the lo end and sealed at the upper, is ground to fit neck of the bottle like a stopper. When w drawn, a drop of the liquid falls from it, and warmth of the hand expels its contents gutta When only small quantities of the reagent required, the tube may be used both as bottle pipette. The sealed end may be heated in flame of the spirit-lamp and the open end immer in the liquid, which will flow into it as the g cools. In making extempore solutions in a wa glass, or on a flat surface of glass, as well a some delicate manipulations, a spatula, consis of a triangular piece of window-glass groun the edges, thinned at the point, and inse in a wooden handle, as shown in fig. 46, will found very serviceable. The smallest fractio a drop of liquid may be taken up from drip of the pipette, and the sides may used to crush small crystals, as well as to draw from the sur of a liquid containing sediment a portion of clear liquid. A p of platinum wire inserted in a handle, and ground to a point, be substit .ted for a steel needle as being more cleanly, and curved brass forceps may be commended as the best form these and similar uses. A drop of the liquid supposed to con poison is to be placed on a glass slide, or the centre of the g disk presently to be recommended for microscopic sublimates, carefully examined: the reagent is then to be added without turbing the slide or disk, and the immediate effect observed well as those changes which take place more slowly; and la the liquid having been allowed to dry under cover, is again s mitted to examination. The reactions thus produced may t place instantaneously, quickly, or slowly, and they may show th selves on the surface of the glass or liquid, or in the body of liquid itself. If crystals are formed they may float, lie flat the glass, or stand up in the fluid as corn on the ground. In dry spots, also, they may be found on the glass, or projec from it. It is this variety of place and position that renders binocular microscope so important, and even essential; for i no exaggeration to say that a microscopic crystal is not fully s till it is viewed by this instrument. In using reagents wi

Fig. 46.

consist of saline solutions, two most important precautions should never be neglected. The solution should be of a defined strength, and the form of the crystals which it leaves on evaporation should be previously ascertained. These crystals, with very rare exceptions, will be found forming part of the dried spot. For most test-solutions 1 part by weight in 100 is a suitable strength. In some cases, perhaps, it may be well to cover the drop of liquid with a disk of thin glass, and to apply the reagent to the margin.

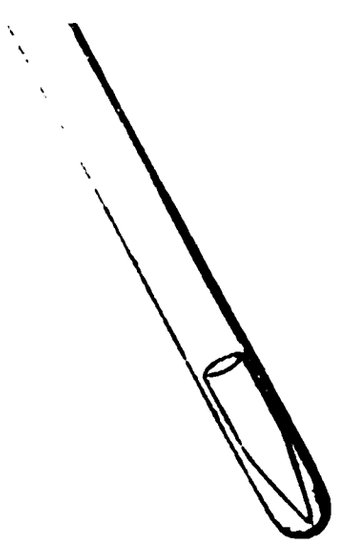
Fig. 46.



3. *The method of sublimation.* — This method, always largely used in testing for poisons, has lately acquired a new and increased importance from the interesting discovery of Dr. Helwig, of Mayence,* that the alkaloids, when sublimed in the manner which I recommended some years since† for arsenic, corrosive sublimate, and other inorganic poisons, also yield sublimates, some of which are eminently characteristic in their microscopic forms and in their reactions. In attempting to verify the statements of Helwig, I have seen reason to modify his method, and to extend it to a much larger class of objects. (G.)‡

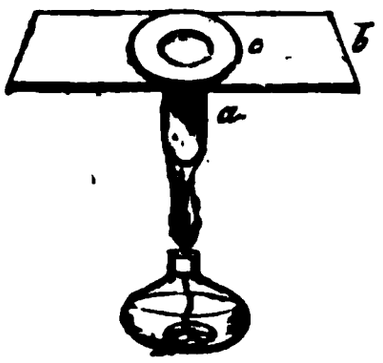
The simplest form of sublimation is with the spirit-lamp and platinum foil. It deals with small quantities of matter, and affords many useful indications. Some poisons, as arsenious acid, corrosive sublimate, oxalic acid, and cantharidine, are sublimed without residue; others, such as the alkaloids, change colour, melt and deposit carbon, and some others undergo no characteristic change. Another method of sublimation commonly practised consists in the use of the spirit-lamp and test-tube, and this, in certain cases, as in those of arsenious acid, corrosive sublimate, and the metals arsenic and mercury, has the twofold advantage of exhibiting the changes caused by heat in the poison itself as well as the character of the sublimate deposited on the higher part of the tube. When this method is practised, great care should be taken to avoid soiling the inside of the tube in introducing the substance under examination. This may be done either by using

* 'Das Mikroskop in der Toxikologie,' 1868.
† Beale's 'Archives,' No. iii. 1868.
‡ See 'Pharmaceutical Journal,' June to October, 1867; and 'Journal of the Royal Microscopical Society,' January, 1868.



lain or brass, *b*, and hold

Fig. 48.



operation with other disks

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spirit-lamp is then withdrawn, a fresh disk applied, and the operation repeated. When this simple operation is carefully performed, no part of the sublimate escapes. But as it may be well to guard against such escape when dealing with very small quantities of matter, and some operators accustomed to the test-tube may prefer some modification of it, the following is suggested:—Draw out a small tube of green glass *a a'* into the form shown in fig. 51; dry the tube by passing it repeatedly through the flame of the spirit-lamp. Introduce the substance to be sublimed into one of the open ends of the tube, as at *b*. Seal the tube at *a*, and shake the slips down to the sealed end. Place the tube in a good side light, and, after heating the capillary portion, apply the flame of the lamp steadily to the end. When the sublimate shows itself, as at *c*, draw off and seal the capillary tube at *d* *d* and mount it for the microscope in the manner shown in fig. 52, which represents a card the size of the common glass slide with a central aperture enlarged by side cuts. The capillary tube *c d*, rests on a perforated label gummed to the back of the card, and is confined to its place by

Fig. 49.

Fig. 50.

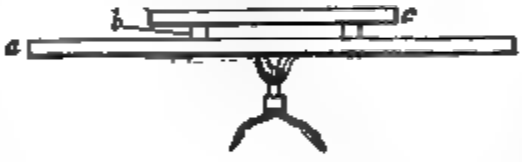
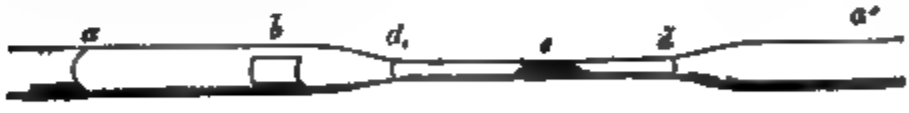


Fig. 51.



the slips of gummed paper *a a*. Write a memorandum of the date and circumstances of the reduction on the card. As the sides of the capillary tube *c d* are exceedingly thin, they offer no impediment to an examination of the stain *b*, with the higher powers of the microscope, especially if for the round glass tube we substitute a flattened glass tube with long oval section. But the simple method of procedure described above (fig. 50) is the one that has the greatest value as a means of diagnosis; for it combines the advantage of the platinum foil with that of the reduction tube, inasmuch as the white surface of porcelain seen through the glass disk shows clearly the direct effect of heat, while the disk carries the sublimate in a form admirably adapted to microscopic examination, and the subsequent use of reagents. To show the

of a grain of strychnia, and much l
grain of the *powder* of cantharides.

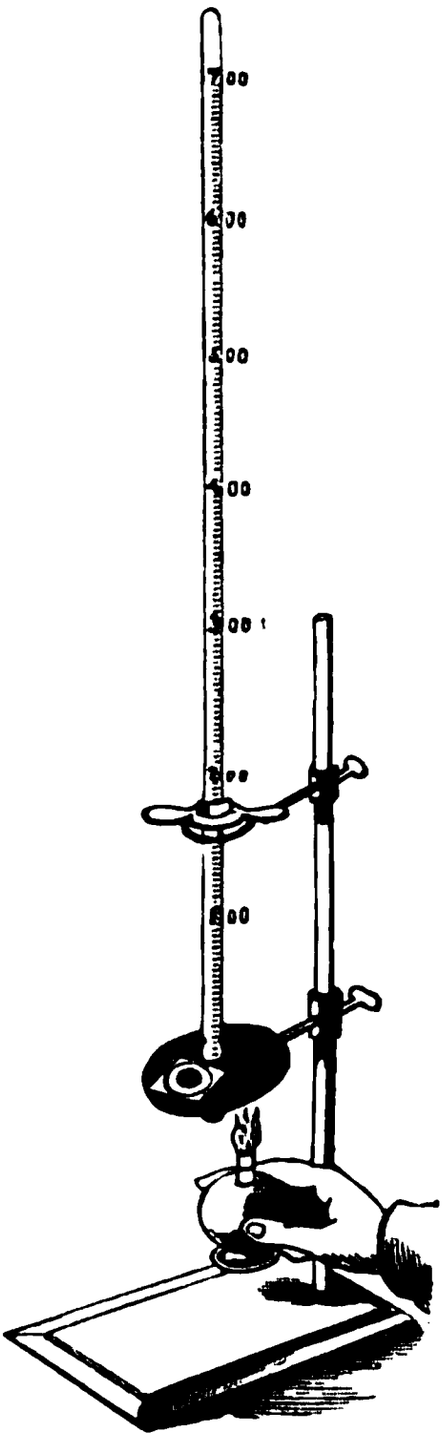
But it is possible to add greatly t
method by a simple arrangement fi
which changes of form and colour, a
This may be effected by substituting
of copper with a hollow nipple mad
indicating degrees of heat up to 60
stance to be examined is to be plac
scopic glass, the glass on the coppe
it, and the disk of glass upon the ri
lamp is then to be steadily applied
copper at a point equidistant from t
thermometer. This arrangement wi
reference to fig. 53.

The following are examples of th
as a diagnostic of some of the most
quantities as the hundredth of a gra
duced to powder:—

a. Corrosive sublimate, no change

c. Strychnia.—No change of form or colour till sublimation at 345°; at 430° melts, darkens, and deposits carbon, still yielding sublimates. *Morphia*, no change of form or colour till 330°, when it sublimes, melts at 340°, darkens and deposits carbon, still yielding sublimates.

Fig. 53.



d. Digitaline. — Darkens, then melts and sublimes at 310°. *Aconitine* melts at 140°, changes colour at 280°, sublimes at 400°. *Atropine* melts at 150°, sublimes at 280°. *Veratrine* melts at 200°, sublimes at 360°, yielding isolated crystals.

Of the method of sublimation conducted in the manner just described, with or without the thermometer, it may be observed further that it is applicable to the following distinct purposes:—The direct sublimation of white powders or colourless crystals; the sublimation of deposits from solutions; the separation of active volatile poisonous principles from powders which contain them as constituents or admixtures. The following are given as illustrations:—Take a crystalline speck of strychnia. It will yield a distinct white sublimate. Take such a quantity as the $\frac{1}{100}$th grain. It will yield several successive sublimates before and after melting. From the thickest of these proceed to obtain secondary sublimates. Dissolve a grain of arsenious acid in an ounce of distilled water; evaporate a drop on a slab of porcelain and sublime the dry residue. Take the $\frac{1}{100}$th grain of powdered cantharides. It will yield a well-marked sublimate, rendered very distinct if moistened with a drop of ether. Take a drop of the liquid used for browning gun-barrels, which consists of corrosive sublimate, muriate of iron, a salt of copper, and spirits of wine: evaporate it to dryness. It is crystalline, as seen under the microscope. Sublime off the corrosive sublimate, leaving the

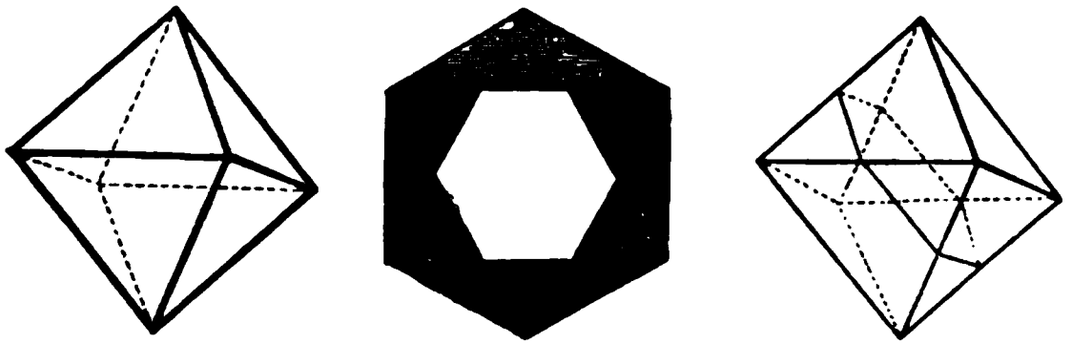
by sublimation and by deposit from sol
defined and highly characteristic cryst
forms may happen to be common to n
deposit, or they may be imperfectly de
by amorphous forms. And here liquid
great advantage; and, as the constitu
when very small in quantity, are in a
results are highly satisfactory. When, f
of strychnia and corrosive sublimate do
racteristic crystalline forms, their true
mined by the addition of the smallest
reagent; and with proper care, there
application to the same spot of all the
found to give characteristic results. T
minute quantities of liquid, the pipette
commended, readily lend themselves. T
of liquid may be taken from the drip o
point of the spatula (figs. 45 and 46, pp.

5. *Crystalline forms.*—Crystals play
the detection and identification of mine
whether they are obtained by sublimati
tion, or by reaction of liquid with liqui
spot. Now, crystalline forms, however
modifications, with the nature and cause
acquainted. Fortunately, the crystal-

to be found in almost every group of crystals, may be advantageously considered.

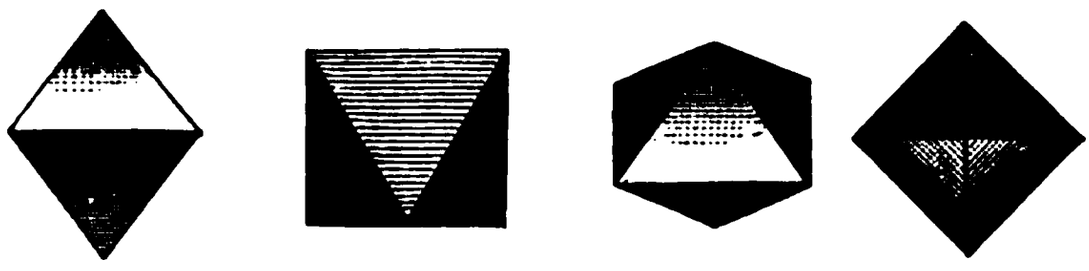
The regular octahedron is shown in outline in fig. 54; as it

Fig. 54. Fig. 55. Fig. 56.



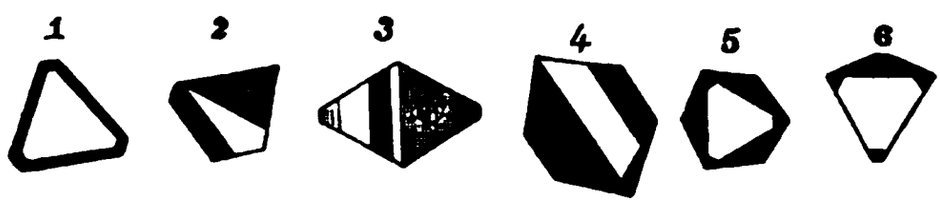
appears when a glass model of it is seen with a triangular facette in advance, in fig. 55; and as cleft by a plane parallel to two of its sides in fig. 56. It consists of eight equilateral triangles joined at their edges; and a section passing through four edges, so as to divide the crystal into two equal parts, shows a perfect square. The section shown in fig. 56 also divides the crystal into two equal parts, each of which has an equilateral triangle for one face and a hexagon for the other. The entire crystal presents itself under different aspects, according as it adheres by an angle, face, or edge, and the light traverses, or is reflected from it. In opaque models, or in groups of crystals seen by re-

Fig. 57.



flected light, two, three, or four sides only are displayed as in the annexed illustrations (fig. 57). But when the light is trans-

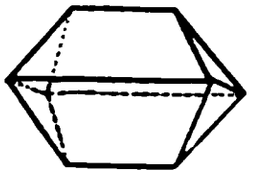
Fig. 58.



mitted through the crystals, these forms are modified and disguised by such shadows as those shown in fig. 58. It is not often

that the eight sides of the octahedron are visible, as in the fifth of the series, in which the three receding triangles and three dark triangular spots represent six sides, and the two parallel equilateral triangles, the seventh and eighth. Sometimes the octahedron, instead of being moulded on a square, is built on an oblong, assuming the form shown in fig. 59.

Fig. 59.

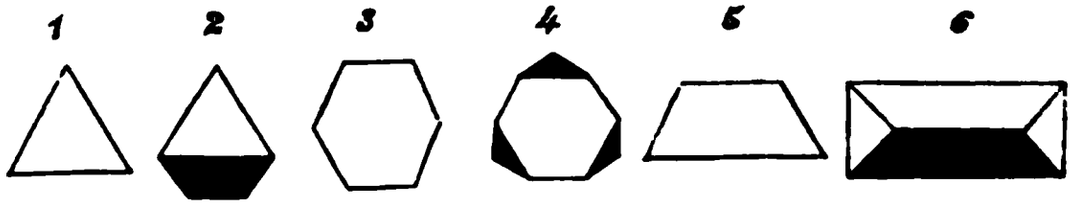


In most groups of crystals these forms will be recognised; but it should be understood that the octahedron is not always perfect. Its angles may be truncated, sometimes one, sometimes more than one, sometimes all. Its sides may also be indented and its angles rounded, so as to resemble a trefoil (fig. 60).

Fig. 60.

Again, the half crystal formed by the section indicated in fig. 56, like the entire crystal, may present itself in many different attitudes:—1, as a simple equilateral triangle; 2, as an equilateral triangle resting on half the adjoining triangle as a base; 3, as a simple hexagon; 4, as a hexagon with three small equilateral triangles in shadow; 5, as a truncated equilateral triangle; 6, as a figure having the appearance of a triangular prism (fig. 61).

Fig. 61.



These half crystals, by the juxtaposition of their corresponding parts, constitute twin-crystals, or *macles*, as in figs. 62 and 63. Rectangular prisms, of which fig. 64,

Fig. 64.

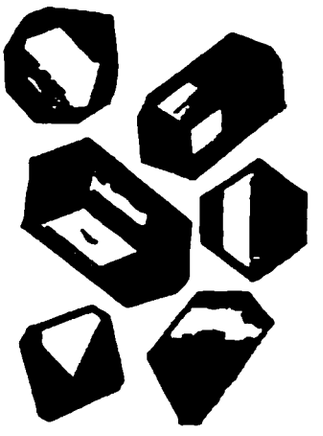


Fig. 62.

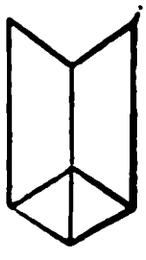
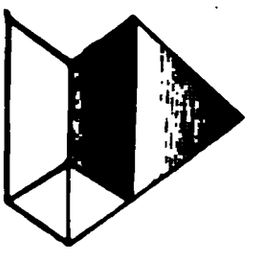


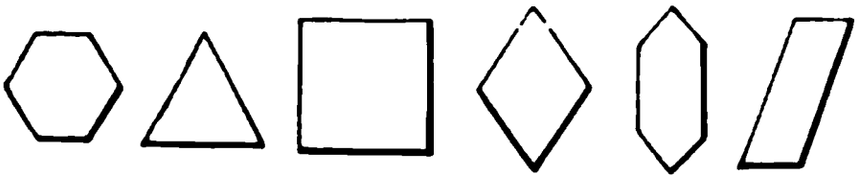
Fig. 63



faithfully drawn from a photograph, contains two specimens, are of less frequent occurrence.

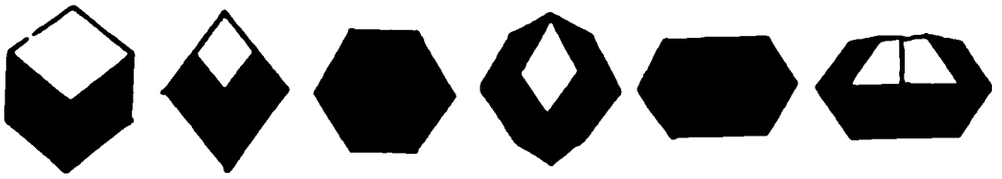
Plates various in form, size, and thickness are also very common in some specimens (fig. 65).

Fig. 65.



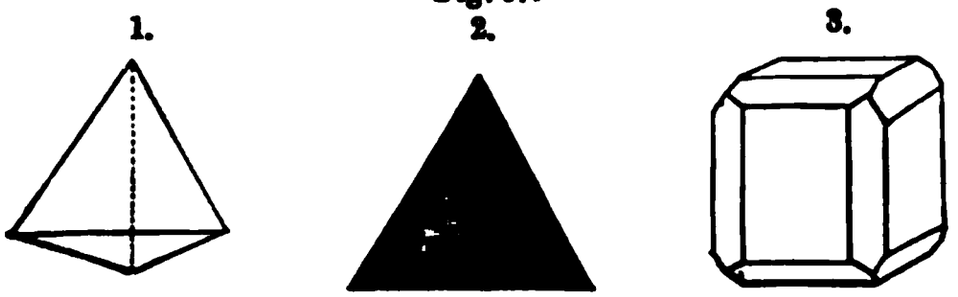
The rhombic dodecahedron, in the various positions shown in the first four of the figures annexed (fig. 66), and the *macles*, or

Fig. 66.



twin-crystals, depicted in the fifth and sixth, go far to complete the history of the crystal of arsenious acid taken as an example of a crystal of definite form, putting on appearances the most various through difference of position, imperfect development, rotation of half crystals, and modifications of form in harmony with the cubical system to which it belongs.*

Fig. 67.



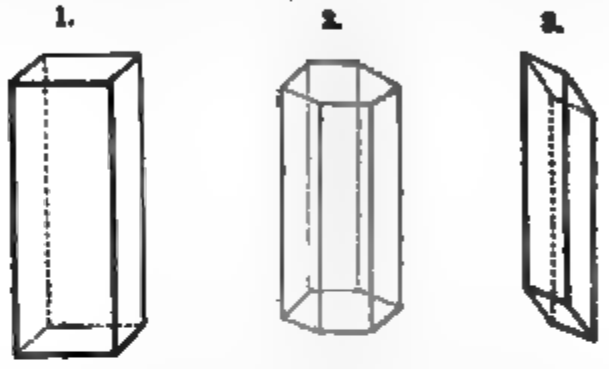
Another crystal which has a certain medico-legal interest, from being present in some deposits from solutions of tartar emetic, is the tetrahedron, shown in outline in (1) fig. 67, together with the alternative form, consisting of a cube with its edges removed, as at 3.

The tetrahedron consists of four equilateral triangles, joined at their edges, and presents itself very constantly in the manner shown in the shaded crystal (2, fig. 67).

* Those who desire fully to understand, or clearly to explain, the crystals of arsenious acid, should study them on the large scale in octahedra of wood and glass, referring to the 'Mineralogy and Crystallography' of Tennant and Mitchell, and using the binocular microscope.

The remaining crystals with which we have to deal in medico-legal inquiries, are chiefly the prismatic forms and plates which figure so largely among the sublimates and deposits from solutions of the alkaloids. Those most deserving of notice are:

Fig. 68.



1, the rectangular four-sided prism of strychnia; 2, the six-sided prism of morphia; 3, the right rectangular prism of oxalic acid and sulphate of zinc.

The cubic crystal of iodide of potassium and common salt (1, fig. 69), the deep six-sided plates of strychnia, as deposited from solutions in benzole (2), the pentagonal dodecahedron found in the same deposits (3), and the deep square plates of bichromate and ferrocyanate of potash (4), are also worthy of attention. The rhomb (5) is of less medico-legal interest.

Fig. 69.

The crystals obtained by sublimation of the alkaloids, from their solutions in various menstrua, and from their reactions; indeed crystals from every kind of solution, are subject to great variation in form and grouping.

The causes, of which it is most important to take note, as determining the forms of crystals, are temperature, quantity of material, and strength of solution. Of *temperature*, it will suffice to observe that sometimes, as in the case of sublimates of arsenious acid, it will determine whether a deposit shall be crystalline or amorphous, in others, as in solutions of common salt, whether the crystals shall be cubes or octahedra; of *quantity*, that, in the case of the sublimates of the alkaloids, it has been

recognised that the smaller the quantity the more defined the crystals; of *strength of solution*, that this will of itself sometimes determine the form of compound crystals, as in the case of bichromate of potash, which, in strong solution, yields a deposit of deep plates and prisms, in weak solution, of a delicate arborescence. (See Bichromate of Potash.) So important is this cause of variation, that I have thought it expedient throughout this work to indicate the strength of the solution to be tested, as well as of the reagent, adopting for both, as most convenient, the same fraction of one per cent. This precaution is, at least, as necessary as affixing to microscopic objects the scale of enlargement. (G.) In the case of crystals forming under the microscope, different forms of crystal will develope themselves in a deep undisturbed drop and in a thin layer.

6. *Spectrum-analysis.*—This elegant and delicate method of detecting and identifying minute quantities of matter has already been described (p. 325) and applied to distinguish the dissolved colouring matter of the blood, whether pure, or acted on by reagents, from colouring matters having the same tint. Of the extreme delicacy of this method there can be no doubt; but it is one requiring for its successful and safe application practised skill and great care, and cases must be extremely rare in which other more simple and ready methods having failed, we should feel compelled to resort to this.*

To complete the account here given of the methods of analysis applicable to the detection of minute quantities of poison, some notice ought, perhaps, to be taken of the use of *polarized light*, and of the facts relating to *fluorescence*. Of the extreme delicacy of the tests arising out of the application of these phenomena, and of their high value when applied by skilful and practised persons, there can be no doubt; but the descriptions and explanations necessary to enable the student to apply them with safety would occupy more space than is consistent with the plan of this work. For clear explanations of these optical phenomena, the reader is referred to Miller's 'Elements of Chemistry,' Part I.

* The reader is referred to Professor Beale's 'How to Work with the Microscope,' 4th edit. p. 218, for a paper by Mr. Sorby himself. Also to 'The Microscope, its History, Construction, and Application,' by Jabez Hogg, sixth edition, p. 119 and p. 735. for a full description of the instrument. See also the 'Proceedings of the Royal Society,' vol. xv. No. 92, for a paper by Mr. Sorby, explaining his scale of measurement; and the 'Pharmaceutical Journal,' Feb. 1863, for a Lecture on Spectrum Analysis, by Prof. W. A. Miller, M.D., V.P.R.S., for a condensed history of the origin and progress of this interesting method of research.

CHAPTER IV.

CORROSIVES.

I. THE MINERAL ACIDS.

SULPHURIC, NITRIC, AND MURIATIC.

II. THE ALKALIES AND THEIR CARBONATES.

POTASH, SODA, AND AMMONIA.

THE mineral acids, with the alkalies and their carbonates, make up together a well-defined group of *simple corrosives*—that is to say, of poisons of which the symptoms are due solely to energetic local action. They have no specific remote effects; and in this they differ from the metallic corrosive poisons (the chlorides of mercury, antimony, and zinc, and the nitrates of mercury); from oxalic acid in strong solution; and from phosphorus and iodine in substance.

I. THE MINERAL ACIDS.

In the five years 1852–56, 77 cases of poisoning by these acids were registered, of which 73 were by sulphuric, 2 by nitric, and 2 by muriatic acid.

Poisoning by the mineral acids is not often a homicidal act; but they are sometimes given to adults in place of medicine, or poured down the throat while they are asleep or intoxicated: and more frequently to young children by their mothers or nurses. In infants the act is homicidal, in children either homicidal or accidental, in adults generally suicidal. The mineral acids have also been administered otherwise than by the mouth. One acid (the sulphuric) has been injected into the vagina, another (nitric acid) has been poured into the ear.

These acids are also sometimes used to disfigure the person, or destroy the clothes, or to imitate the destructive action of moths. The sulphuric acid is the one commonly chosen for the work of disfigurement.

The Mineral Acids have the following familiar properties:—they char and destroy organic matters; discolour, and corrode, or injure, the texture of black cloth; redden vegetable blues; and alter or discharge the colour of dyed articles of dress.

The *symptoms* common to these acids are:—a sour taste and burning pain in the mouth, throat, and gullet, *immediately* after swallowing the acid, followed by excruciating pain in the stomach, eructations, constant retching, and vomiting of a brownish or blackish matter containing blood, coagulated mucus, flakes of epithelium, or portions of the lining membrane of the gullet and stomach. The act of swallowing is painful, or even impossible, and there is intense thirst. The bowels are costive, the urine scanty or suppressed, and the patient is teased with constant tenesmus and dysuria. The pulse is generally small and frequent, the respiration catching, and sometimes laborious, and the countenance expresses intense anxiety. In some cases the acid passes into the windpipe, and causes a harassing cough, with croupy respiration and hoarse voice, and the accumulation of tenacious mucus discharged with difficulty, and threatening instant suffocation. The lips are shrivelled, and blistered or excoriated, or they present spots of the characteristic colour of the acid bordered with red; the cheeks and chin are also spotted, and discoloured streaks run from the angles of the mouth. The inside of the mouth is white, shrivelled, and corroded, brown or yellow, and the teeth loose and discoloured. The tongue is sometimes white and polished, sometimes discoloured. Distinct marks of the acid are also commonly found on the neck or fingers, and on the clothes; and the vomited matters, if rejected on a limestone pavement, cause effervescence. In fatal cases, death is generally preceded by symptoms of collapse, the intellectual faculties remaining clear to the last. Some patients die convulsed, others suffocated. Severe nervous symptoms, such as trismus, tetanus, epilepsy, and delirium are occasionally present, and rashes sometimes appear on the skin.

These poisons may destroy life in such small quantities as one or two drachms, and in such short periods as two hours or less. But the patient may linger for days, weeks, or months. In chronic cases he is feverish; has a dry skin and frequent pulse; occasionally vomits his food mixed with flakes of false membrane, or portions of the lining membrane of the gullet and stomach, similar flakes being sometimes discharged from the bowels; and suffers from salivation with fœtor of the breath. The belly is tense; the breathing short and difficult; there are pains and cramps of the limbs; digestion is impaired; all the functions of the body languish; extreme emaciation supervenes;

gullet, and windpipe; or it may act
death by suffocation.

The mineral acids have been injec
or poured into the ear; and in all th

The *post-mortem appearances* co
are the following:—The lips, chin, a
are marked by the acid in the manne
membrane of the mouth, tongue, and
brown, shrivelled and corroded; and
white paint. Portions of the tissues
times they are gangrenous, sometime
may be contracted or swollen, the rin
the larynx inflamed. The gullet pre
as the mouth and throat, and it is
membrane more or less extensively d
428.) Sometimes it presents the pec
eaten appearance shown in fig. 71. In
seat of ulceration, and is perforated.
escapes. The stomach is usually diste
with a yellow, brown, or black glutinous
into the gullet and commencement of t
lining membrane is highly inflamed,
injected with black blood; as in fig. 73
extravasated into its substance; the ru
tensive destruction of its coats, ulceratio
frequent

Exceptions to the general rule of the post-mortem appearances are numerous, arising either from the strength and quantity of the acid, the full or empty state of the stomach at the time, or the part of the alimentary canal which the poison reaches. It may not pass beyond the mouth, it may not enter or pass the stomach, and its action may be limited to the upper part of the windpipe.

The *diagnosis* of poisoning by the mineral acids is easy. The sour taste, the *immediate* commencement of the symptoms, the extensive disorganization of all the parts with which the acid comes in contact, the absence of diarrhœa, the stains on the skin, and the injury to the clothes, form a combination not to be attributed to any other cause. In the great majority of cases, both symptoms and post-mortem appearances are decisive of themselves, but when combined they leave no room for doubt. In almost every instance additional evidence is afforded by chemical analysis.

Treatment.—The best antidote would be calcined magnesia, or the carbonate, mixed with water, or with milk and water. But as these are not likely to be at hand, chalk or whiting, the plaster from the ceiling or wall of an apartment, milk, oil, or soap-suds, or soda or potashes, mixed freely with water, should be given without delay. Milk, mucilaginous and oily drinks, and dilute alkaline solutions, should be given freely and frequently for several hours or days.

The corroded and softened state of the parts would forbid the use of the stomach-pump, even if it were possible to introduce it. If the patient is quite unable to swallow, a cautious attempt may be made to introduce the tube into the œsophagus beyond the obstruction. The subsequent treatment must depend on the nature and severity of the symptoms. Leeches to the pit of the stomach are likely to afford relief, and, if grateful to the patient, ice in substance, or iced drinks may be prescribed. The bowels must be kept open at first by injections of thin gruel, and as soon as aperients appear safe, by castor oil, previously well-mixed with about twice its quantity of hot milk, and given cold. Excoriations on the surface must be treated as burns.

I. SULPHURIC ACID. (*Oil of Vitriol.*)

In the five years 1852–56, sulphuric acid was credited with 73 out of the 77 deaths attributed to the mineral acids, and it takes the fifth place among the poisons in order of frequency.

The strong acid is sold by druggists and oilmen as "oil of vitriol" to blacking-makers; and the dilute acid as "vitriol," "spirit of vitriol," or "essence of vitriol," for cleaning utensils of

...quantities of arsenic, that po... and chemicals as an impurity.

For medico-legal purposes, we ha... 1. *The strong acid.* 2. *The dilute* ... 4. *In organic mixtures.*

1. *Strong Sulphu...*

A heavy oily liquid, not fuming, ... found in commerce, of a light bro... matter, and, when added to water, gi... with copper turnings, sulphurous ... liberates iodine from iodic acid. It ... ral of the alkaloids, with or witho... veratrine it turns first yellow, then, ... colour is immediately produced by w... characteristic reaction of the free acid ... when warmed a clear blue.

2. *Dilute Sulphur...*

A colourless liquid, of a strong acid ... and chars paper when dried,* and giv... of barium a white precipitate, insolubl... cipitate being collected, washed, and ... flux, and heated on charcoal in the r... pipe, is converted into the sulphide; ... dilute hydrochloric acid ...

by appropriate tests. Wormley recommends veratrine as the best test for the free acid, and one in every respect superior to Runge's cane-sugar test. If a fragment of the alkaloid be dropped into a liquid containing as little as the one-thousandth of a grain of the free acid, and dissolved by the aid of heat, it forms a colourless mixture, which, evaporated to dryness, leaves a deposit with a fine crimson border.

3. *Stains on Cloth.*

The strong acid stains black cloth, first red, then brown, and corrodes it. The stain continues moist for months or years, and has an acid reaction. The dilute acid produces the same change of colour, and less corrosion; but the spots are dry.

To detect the acid, the stained fragment of cloth must be boiled in a small quantity of distilled water, the liquid filtered, and tested for the free acid. A drop of the filtrate should be evaporated on a glass slide, and if a visible stain remains, it should be examined for saline matters, and an unstained portion of the same cloth should be examined in the same way.

Clean linen and cotton fabrics corroded by the acid may be submitted to destructive distillation in a reduction-tube, in the mouth of which a slip of filtering paper, moistened with solution of starch, and sprinkled with iodic acid, is placed. The released iodine reveals its presence by the blue iodide of farina. This process is not applicable to woollen textures, which contain sulphates, to the coats of the stomach, or to its contents. A parallel experiment should always be made with an unstained portion of the same material.

4. *Organic Mixtures.*

Liquids containing organic matter, such as tea and coffee, beer and porter, if thick or turbid, must be boiled with distilled water, and filtered through paper supported by muslin; if clear, they may be filtered at once. The coloured precipitate thrown down by nitric acid and nitrate of baryta is to be collected, boiled in strong nitric acid, to destroy the organic matter, and converted into sulphide of barium, as above.

The contents of the stomach, or the vomited matters, will have a strong acid reaction if no antidote has been given; but if the case has received medical treatment, or the patient has survived some time, they may be neutral or even alkaline.

a. If they have an acid reaction, it is probable that they contain a free acid, which may be the sulphuric, or one of the two acids usually found in the stomach, the acetic and hydrochloric. These

for sulphuric acid.

If the fluid has an acid reaction a
on evaporation; and the result of d
acid is the sulphuric, we are dealing
such as alum, or with a sulphate, su
with free sulphuric acid. In the lat
baryta till effervescence ceases, and
acid from the weight of the resulting

b. If the organic matters have
neutral, they must be boiled in dist
tests being applied to the filtered liq

If carbonate of lime has been
resulting sulphate must be dissolved

If the quantity of acid discovered
very small, there is no proof that it
secretions of the stomach always con
tral sulphates. Nor does the disc
such as the sulphate of magnesia,
free sulphuric acid, for the salt itsel
aperient. The discovery of sulphate
the administration of sulphuric acid
chalk as an antidote, would be as co
free acid.

But where the characteristic ap
sulphuric acid are present, chemical

Quantitative Analysis.—Use for this purpose the precipitated sulphate of baryta, boiled in pure nitric acid, washed and dried. 100 parts of the sulphate contain 41½ of the strong acid.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Those already described at p. 415, but severe in proportion to the strength and corrosive properties of the acid. Severe nervous symptoms are sometimes present, such as locked-jaw, rigid spasms of the extremities, epilepsy, and delirium.

Diagnosis.—The dark-brown stains on the skin, and the moist brown corroded stains on black cloth, are characteristic.

Post-mortem appearances.—Those described at p. 416; but the disorganization greater, and perforation more frequent (about a third of the cases), than in poisoning by the other mineral acids. The colour of the epithelium and mucous membrane dark-brown or black, as if charred; while in cases of poisoning by nitric acid it is more commonly yellow or green. When thickly coated with mucus, the lining membrane of the mouth and alimentary canal seems smeared with white paint. This is the effect of the acid on the secretions of the canal after death (Dr. Chowne). The post-mortem effect on the mucous membrane itself is to render it yellowish and brittle, to bleach the muscular and peritoneal coat, and to char the blood in the vessels (Orfila).

Fatal dose.—In the adult, one drachm: in an infant five weeks old, half a drachm. Four ounces have been swallowed by an adult without fatal consequences.

Fatal period.—*Shortest* one hour: in a child "*almost immediately.*" Life may be prolonged for several days, weeks, or months, up to the limit of two years. *Average.*—In cases that prove fatal in 24 hours, about 10 hours.

Mortality.—Almost all infants and young children. In adults, two-thirds of the cases.*

Treatment.—That already described at p. 417.

* The following are the results of several cases reported in the English and Foreign Journals:—

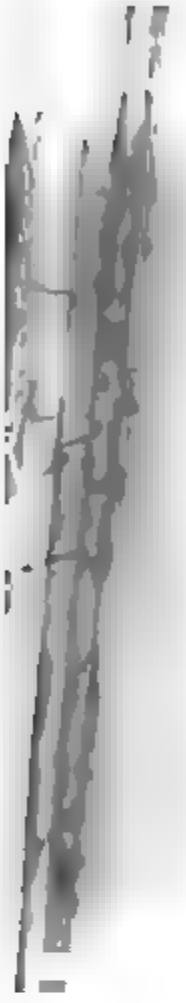
Of 36 cases (the majority females)—26 were fatal (all the children and 18 adults), and 10 recovered (all adults).

Of 31 cases—20 were suicidal, 3 homicidal (all young children), and 8 accidental (2 of them children).

Among adults, both in accidental and suicidal poisoning, there was 1 recovery to 2 deaths.

Of the 26 fatal cases, 10 lasted a day or less; 6 more than a day and less than a week; 3 less than a fortnight; 1 from a fortnight to three weeks; 1 more than three weeks; and 5 extended from five to forty-five weeks.

The *least* duration in 5 children was three and a half hours, the greatest



... thus injured consists in the
of potash or soda till effervescence
priate to burns.

II. NITRIC ACID (*Aqua Fort*

This acid is much less in use as
but much more than hydrochloric
only in the five years 1852-56.

The poison may present itself fo
acid. 2. *The dilute acid.* 3. *In st*
mixtures.

1. *Strong Nitr*

The commercial acid varies in colo
light yellow; gives out orange-colour
yellow stains in woollen tissues, and
similar stains in other articles of dres
other tissues of the body. These sta
tint when touched with an alkali.
effervescence and escape of ruddy aci
remaining. With morphia and its a
orange colour, effervesces, and gives o
brucia a blood-red.

2. *Dilute Nitric*

A volatile acid liquid, which redden
cipitated by nitrate of baryta or nitr
absence of precipitate with these reagen

the acid is neither sulphuric nor hydrochloric, nor any of the common vegetable acids. This presumption is converted into certainty by the following tests:—*a*. When boiled with copper filings, provided the acid be not very dilute, the characteristic orange fumes are given off. *b*. If carbonate of potash is added to the liquid till effervescence ceases, and a piece of filtering paper is dipped into the liquid and dried, it burns like touch-paper. *c*. On slowly evaporating the liquid, it yields crystals of nitrate of potash, of the form annexed.

Fig. 70.

Solution 1 in 100.

The crystals of nitrate of potash so obtained from the solution, yield corroborative proofs of the nature of the acid, by the following reactions:—*a*. When ignited on charcoal, they burn with deflagration. *b*. On adding strong sulphuric acid, a colourless vapour with the peculiar odour of nitric acid is given off. *c*. Drop a fragment of the salt into a small test-tube, add a few drops of distilled water, and then a drop of strong sulphuric acid; drop in a fragment of copper: the characteristic ruddy fumes are given off. *d*. Proceed as in *c*, and add one or two drops of strong hydrochloric acid: the resulting liquid dissolves gold leaf. The following tests are best applied on a slab of white porcelain:—*e*. Moisten a crystal of the salt with distilled water, add a drop of pure concentrated sulphuric acid, and dissolve by the heat of a spirit-lamp, allow the liquid to cool, and introduce into it a fragment of the green sulphate of iron; a dark green ring, changing to brown, will form round the crystal. *f*. Proceed as in *e*, and substitute a fragment of morphia. It strikes a rich orange colour, and yields a yellow liquid. *g*. Proceed as in *e*, and substitute a fragment of brucia. It strikes a blood red. *h*. Proceed as in *e*, and add a fragment of narcotine. A reddish-brown colour is produced, changing with a gentle heat to deep blood-red. The following may be added as an excellent test for any nitrate. Place in a test-tube a few drops of sulphuric acid, and add a little distilled water: then a fragment of pyrogallic acid. Allow a few drops of strong sulphuric acid to trickle down the side of the tube and subside to the bottom. Add a few crystals of common salt, and when the effervescence ceases, drop in the crystal of the nitrate. The acid at the bottom of the tube puts on an intense purple hue, which may extend to the rest of the liquid. (Hurley, confirmed by Wormley.)

3. *Stains on Cloth.*

Boil the fragment of cloth in a small quantity of distilled water. The presence of an acid will be indicated by test-paper; and that of nitric acid by the appearance of the stain. Neutralize with carbonate of potash, and filter. The dry filter burns like touch-paper. Evaporate the liquid, collect and examine the crystals by the microscope, and apply the brucia test as above; and if possible the other tests in succession.

To distinguish stains of nitric acid from those caused by iodine or by bile, test with a weak solution of caustic potash. The indelible nitric acid stain assumes a clear orange tint; that caused by iodine immediately disappears; the bile-stain is unchanged.

4. *Organic Mixtures.*

If the liquid is viscid, dilute with distilled water, boil, and filter. If it has an acid reaction, neutralize with carbonate of potash, crystallize, and apply the tests just described.

If antidotes, such as chalk or magnesia, have been given, the liquid, instead of having an acid reaction, may be neutral or feebly alkaline. In this case, also, the filtered liquid is to be treated with carbonate of potash; soluble nitrate of potash will be formed, and insoluble carbonate of lime or magnesia thrown down, this being separated by fresh filtration. The filtered liquid is evaporated, and the crystalline residue tested for nitrate of potash.

When the quantity of acid in the organic liquid is very small, it may be removed from the vessel containing it by means of a rough syphon formed of filtering paper. (Christison.)

Mucous membrane acted on by the acid may be treated as fragments of cloth.

In the case of nitric as of sulphuric acid, the post-mortem appearances are so characteristic as to render chemical analysis unnecessary.

Quantitative analysis.—To the nitrate of potash add strong sulphuric acid; dissolve the sulphate, calcine it, wash with alcohol to remove free acid, and evaporate to dryness. For one hundred grains of the dry sulphate allow about eighty-two grains of the strong acid.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Those already described (p. 415). A miliary rash, with intolerable itching, was present in one case on the sixth day.

Diagnosis.—The yellow stains on the skin, and the dry

yellow corrosions on the dress, are characteristic of this acid. The discovery of these stains on the person and dress of an accused person has led to his conviction.

Post-mortem appearances.—Those already described (p. 416). The colour of the mucous membrane yellow, or green in parts of the stomach and intestines containing bile. The degree of corrosion less, and perforation more rare, than in the case of sulphuric acid.

Fatal dose.—Two drachms. (Taylor.) In infants less. Recovery has taken place after half an ounce,* or more.

Fatal period (*shortest*).—In the adult an hour and three-quarters: in the infant a few minutes.

Average.—In the majority of fatal cases death takes place within twenty-four hours; but life may be prolonged to several days, weeks, or months.

Mortality.—About half the cases.

Treatment.—As for the mineral acids generally (p. 417).†

Nitric acid has been poured into the ear, and caused sloughing, abundant hæmorrhage, paralysis jactitans, extreme debility, and death in about thirteen weeks.‡

The orange fumes given off when nitric acid is poured upon copper or mercury (and commonly known as nitrous acid gas) are produced in large quantity in some processes of the arts, such as water-gilding and brass-button making. They irritate the eyes and lungs, and give rise to a troublesome cough, renewed by each repetition of the process; and at length becoming habitual. In more than one instance it has proved fatal in periods varying from twenty-seven hours to two days.§ The *symptoms* are burning heat in the throat; tightness at the chest and pit of the stomach; extreme distension and acute pain of the abdomen; nausea and vomiting; purging of a yellow matter; scanty secretion of urine and dysuria; cough, at first dry, then attended by scanty orange expectoration, with extreme dyspnœa, and feeling of impending suffocation; transient delirium; extreme debility; inexpressible anxiety; and death after convulsions. The *post-mortem appearances* consist in signs of acute inflammation and its consequences in the air-passages and lungs, and in the alimentary canal, engorgement of the lungs and heart with black liquid blood, distension of the stomach and intestines with gas, and a yellow colour of the

* 'Lancet,' April, 1870 (Adams).

† Among recent cases of poisoning by nitric acid refer to 'Guy's Hospital Reports,' vol. xvii. p. 223 (Stevenson); 'Glasgow Med. Journ.,' May, 1872 (Dougall).

‡ 'Medical Gazette,' March, 1830.

§ See 'Lancet,' April, 1854; 'Chemical News,' March, 1863.

contents of the air-passages and alimentary canal. Manufacturers who produce these irritating fumes should be required to conduct them into the nearest chimney.

The binoxide or deutoxide of nitrogen gives rise to these orange fumes by combining with air in the lungs. Accordingly Sir H. Davy suffered very severely when he tried to inhale the binoxide.

III. HYDROCHLORIC ACID (*Muriatic Acid, Spirit of Salt*).

Though muriatic acid is somewhat largely employed in the arts, it is not often used as a poison. No case of poisoning by it was reported in the years 1837–38; only two cases in the five years 1852–56. The poison may have to be examined as—1. *The strong acid.* 2. *The diluted acid.* 3. *In stains on cloth.* 4. *In organic mixtures.*

1. *Strong Hydrochloric Acid.*

The acid of commerce is of a yellow colour, fuming in moist air, and yielding dense white vapours with ammonia. It produces a dry green stain on black cloth, but does not corrode it; or the stain is first red and then green. It is distinguished from sulphuric acid by its colour, and from nitric acid by the absence of orange fumes when poured on copper. When boiled with peroxide of manganese, chlorine is given off, known as such by its colour, odour, and bleaching properties.

2. *Dilute Hydrochloric Acid.*

The liquid is proved to contain an acid by the use of litmus paper. The nitric acid and nitrate of baryta test causes no precipitate. It is probable, therefore, that the acid is either nitric or hydrochloric. If a solution of nitrate of silver yields a dense white precipitate insoluble in nitric acid, and in caustic potash, but very soluble in ammonia; and which, when dried and heated, fuses into a yellow liquid, cooling to a soft horny mass, the acid is certainly hydrochloric.

As a chloride (such as common salt) with a free acid would have an acid reaction, and yield the same white precipitate with nitrate of silver, a drop of the liquid should be evaporated, when, if there is a crystalline residue, the acid should be distilled over and the crystalline residue examined by the microscope, and tested.

3. *Stains on Cloth.*

Boil the stained cloth in distilled water, filter, test with nitrate

of silver, and identify the precipitate as above. Examine, at the same time, an unstained portion of the same cloth.

4. *Organic Mixtures.*

Most organic liquids contain hydrochloric acid free or combined, and most organic matters yield a precipitate with nitrate of silver. In the contents of the stomach, the acid may either exist in the free state, yielding a strong acid reaction, or it may be combined with an antidote, the liquid being neutral.

If the liquid has a strong *acid* reaction, we distil it at a low temperature, by immersing the retort in a boiling solution of chloride of calcium (two parts to one of water), the distillation being repeated by adding distilled water to the dry residue. The liquid in the receiver may be treated as pure dilute acid.

The detection of a minute quantity of free hydrochloric acid in the contents of the stomach does not prove its exhibition as a poison, for the gastric juice itself contains a minute proportion (1 part in 1500) of the free hydrochloric acid. But when the acid is found in appreciable quantity in the stomach of one in whom the symptoms and the post-mortem appearances were such as a mineral acid would produce, the cause of death admits of no doubt.

If the organic liquid is neutral, it may either contain no hydrochloric acid, or the acid may be combined with an antidote—magnesia, lime, soda, or potash. In this case we evaporate to dryness and calcine, dissolve the residue, and test the solution with nitrate of silver.

If the residue consist of common salt, it may have resulted from the administration of carbonate of soda as an antidote, or it may have formed part of the food. In this case also the chemical analysis must be confirmed by the symptoms and post-mortem appearances, and the stains which we may discover on the clothes.

Quantitative Analysis.—Use for this purpose the dried precipitated chloride of silver, of which 100 grains are equivalent to 69 grains of liquid hydrochloric acid.

Symptoms.—Those already described (p. 415).

Post-mortem Appearances.—Those already described (p. 416). In a suicidal case, in which a large quantity of the strong acid proved fatal in less than twenty-four hours, the epithelium of the throat and gullet was destroyed in patches, and the stomach contained a large quantity of black grumous matter, adhering to the surface so as to admit of being preserved. The preparation (presented by Mr. Bowman), with a drawing of the gullet and stomach, is in the Museum at King's College. As the appearances in this case, especially the shrivelled and worm-eaten

aspect of the gullet, bear a very near resemblance to those present in cases of poisoning by sulphuric acid (see Rouspell's Plates) and to one case of poisoning by oxalic acid which came under my notice, I append three woodcuts, which, even in the absence of colours, convey a clear idea of the actual appearances. (G.)

Fig. 71.

Fig. 72.

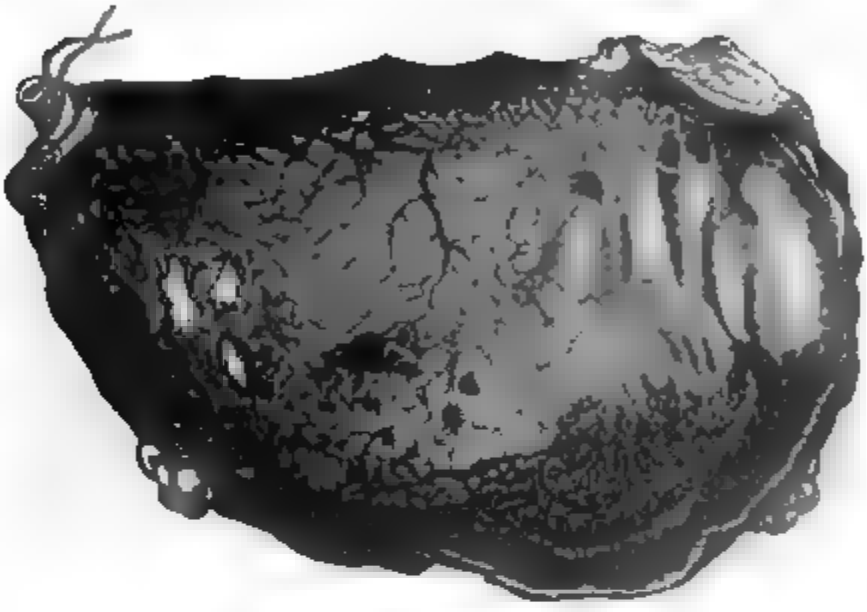
Fig. 71 shows the corrugated and worm-eaten appearance of the gullet; fig. 72 a portion of the gullet from which a large patch of epithelium has been removed, and fig. 73 the appearance of the stomach with its black grumous contents and vessels injected with black blood.

Fig. 73.

In order that undue importance, as a sign of corrosive poisoning, may not attach to the injection of the vessels of the stomach with black blood, or to the removal of portions of the lining membrane, I append an engraving (fig. 74), about one-fourth the natural size, of the stomach of a female prisoner who died from pulmonary consumption. It is taken from a drawing by Dr. Westmacott, made while the stomach was fresh. The black granular appearance of portions of the stomach, the fine black injection of the vessels, the deep red vertical streaks and irregular spots, with the three abraded patches, are remarkable illustrations of the effects of acid secretions of the stomach before and after death. The absence of such appearances in the gullet as are shown above, and of the grumous matters just described, to say nothing of a like absence of characteristic marks on the lips, mouth, and tongue, on the external surface of the body, and on the clothes, would prevent us from attributing such appearances to poisoning.

In the very rare cases in which the corrosive acid, being rapidly swallowed, affects the stomach only, we should expect more

Fig. 74.



marked appearances of corrosion in that organ, together with characteristic grumous matter.

The lining membrane of the stomach and intestines sometimes has a yellow tint, or it is green from the action of the acid on the bile. No case of perforation has yet been reported; but in a case of poisoning by a large dose of the dilute acid reported by Puchelt of Heidelberg, the entire stomach is stated to have been destroyed, and rejected by vomiting.

Fatal dose.—Dr. George Johnson relates a case of fatal poisoning by a tea-spoonful (℥j) in a girl 15 years of age. ('Brit. Med. Jour.,' March, 1871.)

Shortest fatal period.—Five hours and a half.

Average period.—About twenty-four hours.

Treatment.—That of poisoning by the other mineral acids (p. 417).*

Nitric acid mixed with sulphuric, under the name of *aqua regiæ*, and with muriatic acid under the title of *aqua regia*, are used in the arts, the one to separate silver from plated articles and in the manufacture of collodion, the other to dissolve gold and platinum.

* For recent cases consult 'Bull. Gén. de Thérapeut.' 1871, p. 384 (Paul); 'Archiv d. Heilk.,' 1873, p. 213 (Nagar), and Dr. George Johnson's case cited above.

of irritants, the mineral acids, the
animal tissues by the violence of the
to specific remote effects: also that
when swallowed in a concentrated f
solution).

The alkalies and their carbonates,
earths, are distinguished from one
negative effect of sulphide of ammoni
negative effect of hydrosulphuric acid
They resemble the alkaline earths in
but they differ from them in yieldi
bonate of ammonia.

Though they are in common use f
medicines, they are seldom taken as

I. POTASH AND CARBON

Caustic Potash, as used in the l
greyish masses, presenting an imper
is soapy to the touch, acrid to the
fusible by heat, rapidly absorbs carb
is very soluble in water. When fused
it is the *potassa fusa* of the shops.

In solution as *liquor potassæ* it ha
changes the colour of black cloth to
by carbonic or sulphuric acid. but v

We may have to examine and identify these salts—1. *In substance.* 2. *In solution.* 3. *In organic mixtures.*

1. *In Substance.*

Potash (or potashes) is readily recognised by the physical properties just described. The white carbonate of potash resembles in appearance carbonate of soda, and many other white powders. It has an alkaline reaction, effervesces and gives out carbonic acid when treated by acids, imparts a violet tint to the deoxidizing flame of the blowpipe, and is very soluble.

2. *In Solution.*

A solution of carbonate of potash evaporated on platinum foil leaves a white deposit not dissipated by heat, and is thus distintinguished from the salts of ammonia: it has an alkaline reaction; it yields a yellow precipitate with a solution of bichloride of platinum, resembling the salts of ammonia, but differing from those of soda; it gives, with a solution of tartaric acid, a white precipitate of bitartrate of potash, which is promoted by agitation and by friction with a glass rod.

3. *In Organic Mixtures.*

If an organic liquid has a strong alkaline reaction, there is a presumption in favour of one of the substances contained in this chapter. By diluting and filtering the liquid, and applying trial tests, we can ascertain which it is. The process for carbonate of potash consists in evaporating the organic matter to dryness, incinerating the residue, treating the ash with distilled water, and applying to the solution the tests just enumerated.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—When a strong solution of the poison is taken there is an acrid burning taste in the act of swallowing, followed immediately by a burning sensation in the throat and gullet; and this after a short interval by acute pain in the pit of the stomach, with great tenderness on pressure; and frequent vomiting of a tenacious bloody mucus, of a brown grumous matter, or of flakes of epithelium. Violent colic pains, with tension and tenderness of the abdomen soon supervene, with purging of stringy mucus mixed with blood. There is much difficulty in swallowing, and sometimes hoarseness of the voice, and cough. In fatal cases, death takes place from collapse, or after prolonged sufferings from increasing difficulty in swallowing, constant vomiting of blood, bloody stools, and tenesmus. In chronic cases the patient dies from starvation, brought on by stricture of the œsophagus.

Fatal quantity.—Half an ounce.

Fatal period.—*Shortest,* three
rity of cases, within twenty-four
fatal event may be delayed for days

Treatment.—As an antidote, ·
water, or lemon-juice and water.
and the juice of oranges and rip
administered, and almond or olive
by giving ice in substance, or cold
of opium; and collapse, if present,
pump should not be used.

II. SODA AND CARB

Caustic soda has no medico-legal
is sold by oilmen for cleansing pu
and ***best soda***—the soda in a dirty
in masses of a purer white. Carb
identified in substance, in solution,

1. *In Sub*

Carbonate of soda has an alka
gives out carbonic acid when treat
tallises; is efflorescent; and impar
the blowpipe.

2. *In Sol*

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms, Post-mortem Appearances, and *Treatment.*—Those of poisoning by carbonate of potash: the symptoms less severe, and the post-mortem appearances less marked.

III. AMMONIA AND CARBONATE OF AMMONIA.

Gaseous ammonia, dissolved in water, as the *liquor ammoniæ,* or combined with carbonic acid as the *sesquicarbonate,* is largely used in medicine and the arts, and occasionally taken as a poison, generally by accident. The incautious use of the vapour, to rouse patients from fainting fits, has also caused death by suffocation or inflammation of the air-passages.

The vapour of ammonia is readily recognised by its pungent odour, and by the change it produces in vegetable colours being dissipated by heat. The *sesquicarbonate* (vulgarly known as hartshorn, volatile salt, or smelling salts) is recognised by its pungent odour, and distinguished from the carbonates of potash and soda by being completely dissipated when heated on platinum foil. It is distinguished from liquid ammonia by effervescing with an acid, and yielding a white precipitate with the salts of lime.

Ammonia is set free from its salts when they are heated with liquor potassæ in a test tube, the vapour being identified by its odour, by its alkaline reaction, and by the dense fumes formed when brought into contact with hydrochloric acid. Ammonia in *organic mixtures* must first be separated by distillation and then identified by its appropriate tests, of which the most delicate is Nessler's reagent, which gives a reddish-brown colour with traces of ammonia.

Symptoms.—These, as far as they are due to contact, are the same as those caused by potash and soda, and their carbonates; but from its extreme volatility it gains access to the air-passages, and has thus proved fatal in so short a time as *four minutes.*

Post-mortem Appearances.—Signs of violent inflammation in the alimentary canal with separation of the epithelium of the mouth, and inflammatory appearances in the air-passages.

Fatal Dose.—One drachm of the strong Liq. Ammoniæ has proved fatal.* A case of death by 30 grammes,† and another by 50 grammes, has been reported.‡

Fatal Period.—From a few minutes to several hours (3, 4, 11).

Treatment.—Vinegar and water as an antidote, and the after-treatment proper to the class of irritants.

* 'Guy's Hospital Reports,' v. xvii. p. 225 (Stevenson).
† 'Jour. de Chem. Méd.,' July, 1868.
‡ 'Jour. de Chem. Méd.,' May, 1868.

CHAPTER V.

IRRITANTS.

SALTS OF THE ALKALIES AND EARTHS.

The carbonates of potash, soda, and ammonia have been already treated of (p. 430). The binoxalate of potash will be examined with oxalic acid; and the iodide of potassium with iodine. The poisons, therefore, which remain are:—

1. Nitrate of Potash. 2. Sulphate of Potash. 3. Bitartrate of Potash. 4. Sulphate of Alumina and Potash. 5. Sulphuret of Potassium. 6. Chloride of Sodium. 7. Chlorides of Lime, Soda, and Potash. 8. Salts of Baryta.

The nitrate, sulphate, and bitartrate of potash, the sulphate of alumina and potash, and the chloride of sodium, act as poisons, only in large doses. As they are not deemed poisonous, they have been given to discharge worms or to procure abortion. But the sulphuret of potassium, combining the irritant action of the base with the narcotic property of the sulphuretted hydrogen gas, is an active and fatal poison.

1. NITRATE OF POTASH (*Nitre, Saltpetre, Sal Prunelle*).

Poisoning with nitre is generally accidental, being mistaken for sulphate of soda or sulphate of magnesia.

Properties.—It is sold as colourless or nearly colourless crystals, or as crystalline masses; and in white spherical or circular cakes (sal prunelle). It has a salt cool taste, and the familiar property of causing matters with which it is mixed to deflagrate.

Tests.—See nitric acid (p. 423).

Symptoms.—Nitre may be given in such doses as a scruple, two or three scruples, and even half an ounce, without injurious effects. In larger doses of one or two ounces it has acted only as a strong emetic or purgative. But several cases are on record in which doses of an ounce and upwards have produced symptoms of acute irritant poisoning, with profuse discharges of blood by vomiting and purging, and bloody urine. There is extreme prostration of strength, accompanied or followed in some instances by nervous symptoms, such as convulsions, slight trismus, tetanus,

and stupor, loss of speech, sensation, and voluntary motion, and illusions of the senses. In one case there was chorea of two months' duration.

Fatal Dose.—One ounce of the salt has proved fatal. A case of fatal poisoning by 25 grammes (about 375 grains) is reported by Chevallier.* On the other hand, Bailey† reports a case of recovery after 4 ounces, taken by mistake for sulphate of magnesia.

Fatal Period.—Death has taken place in *three* hours.

Post-mortem Appearances.—Acute inflammation in the stomach and small intestines, with black patches in the stomach, resembling gangrene. In one case, a small opening in the stomach.

Treatment.—Vomiting, if absent, to be promoted by emetics, followed by the abundant use of diluents: or the stomach-pump may be used. Antiphlogistic remedies may be required to combat high inflammatory action, sedatives if nervous symptoms are present, and stimulants in case of collapse.

II. SULPHATE OF POTASH (*Sal de duobus, Sal Polychrest*).

This salt has proved fatal when given in large doses. Ten drachms given, in divided doses, to a French lady within a week of her confinement were fatal in two hours, with the symptoms and post-mortem appearances of irritant poisoning. In a suicidal case, an ounce and a half caused marked appearances of irritation in the stomach and small intestines. (Letheby.)

Tests.—The salt is readily identified by nitrate of baryta, as a test for the acid, and bichloride of platinum as a test for the base.

Treatment.—As for nitrate of potash.

III. BITARTRATE OF POTASH (*Cream of Tartar, Argol*).

In such large doses as two ounces and upwards, this salt is a decided poison. It has proved fatal to an adult male in forty-eight hours, with the symptoms and post-mortem appearances of irritant poisoning. It is generally found as a sparingly soluble white powder. The solution has a feeble acid reaction. The powder is converted by heat into carbon and carbonate of potash, which latter effervesces with acids. The base may be identified by bichloride of platinum. It may be obtained as a sediment from organic liquids. The *treatment* is by copious demulcents, and by other remedies appropriate to the condition of the system. A dilute solution of the bicarbonate of potash may be given with

* 'Jour. de Chem. Méd.' Feb. 1868, p. 68.
† 'Phil. Med. and Surg. Rep.,' June, 1872, p. 75.

advantage; as it reduces the bitartrate to the condition of a harmless purgative—the neutral tartrate.

IV. SULPHATE OF ALUMINA AND POTASH (*Alum*).

This substance is not often taken as a poison.

Properties.—It is found in commerce as a colourless crystalline mass, or in the calcined state as a white mass or powder. It is also met with as iron-alum. It has a sour taste, and yields an acid solution, readily distinguished from dilute free acids by evaporation. If a drop of the solution be placed on a slip of glass, it commonly leaves on evaporation a beautiful compound crystal, consisting of straight parallel columns crossed at right angles by short lines, and surrounded by rectangular crystalline forms, blended with regular octahedra. From saturated or strong solutions of alum the crystals are deposited either as octahedra or as cubes, and large masses of crystals, consisting of piles of octahedra, either colourless or coloured, are familiar objects in the shops.

Tests.—The sulphuric acid may be detected by the solution of nitrate of baryta; the alumina is thrown down by liq. potassæ, as a white precipitate, soluble in an excess of the precipitant; and the potash may be detected by the chloride of platinum.

Symptoms.—Those of simple irritant poisoning (p. 378).

Treatment.—That of simple irritant poisoning. After emptying the stomach by the stomach-pump or by emetics, lime-water may be given with advantage.

V. SULPHURET OF POTASSIUM (*Liver of Sulphur*).

The alkaline sulphurets are active poisons, containing an irritant base with a narcotic gaseous acid.

Properties.—It is found in the shops in dirty-green masses, or in powder of the same colour. It yields a yellow solution, and has a strong odour of sulphuretted hydrogen.

Tests.—On adding an acid the gas is disengaged, and produces its characteristic effect on paper moistened with acetate of lead.

Symptoms.—Those of acute irritant poisoning, with the addition of convulsions, or of stupor. The breath, and the matters discharged from the stomach and bowels, have the odour of the gas. Death may occur in so short a time as a quarter of an hour.

Post-mortem Appearances.—Redness of the stomach and duodenum, and deposit of sulphur on the mucous membrane. The surface of the body very livid. The lungs gorged with dark blood.

Treatment.—Dilute solutions of chloride of soda or lime (bleaching liquids) should be immediately administered. The remainder of the treatment is that of irritant poisoning.

VI. CHLORIDE OF SODIUM (*Common Salt*).

Properties and Tests.—The salt is soluble in water, and the solution on evaporation yields cubic crystals. The acid is detected by the solution of nitrate of silver, which throws down the white chloride; and the base by the negative reaction with the bichloride of platinum.

Symptoms.—Those of irritant poisoning (p. 378).

Treatment.—As for nitrate of potash (p. 435).

VII. CHLORIDES OF LIME, SODA, AND POTASH (*Bleaching Powders and Liquids*).

The chloride or hypochlorite of lime (common bleaching powder); of soda (Labarraque's or Fincham's liquid); and of potash (Eau de Javelle), are all poisonous.

Properties.—These substances and solutions yield chlorine spontaneously, or on adding an acid; and they have a strong odour of the gas; and powerful bleaching properties.

The symptoms, post-mortem appearances, and treatment would be those proper to the class of irritants.

VIII. SALTS OF BARYTA.

Properties.—The chloride of barium is irregularly crystallized in tables. It is permanent in the air, soluble in water, and has an acrid taste. The carbonate is a fine white powder, insoluble in water, but soluble with effervescence in dilute acids, and readily decomposed by the free acids of the stomach.

Tests.—Baryta is precipitated from its solutions as a white carbonate by carbonate of potash, and as an insoluble white sulphate by sulphuric acid or the alkaline sulphates. Oxalic acid does not precipitate baryta from dilute solutions. The acids in combination with the base are easily distinguished: carbonic acid by effervescing with dilute acids; muriatic acid by nitrate of silver; nitric acid by precipitating the base with sulphate of potash, when nitre will remain in solution; and acetic acid by the odour of the vapour disengaged on adding dilute sulphuric acid.

Symptoms.—Those of irritant poisoning (p. 378), with the addition of violent cramps and convulsions, headache, excessive

debility, dimness of sight and double vision, noises in the ears and violent beating at the heart.

Post-mortem Appearances.—Those of irritant poisoning (p. 379). In one case, in which death took place in two hours, the stomach was found perforated.

Fatal Dose.—This has not been ascertained; but in an interesting case reported by Dr. Tidy,* where "green fire" was given by mistake for flowers of sulphur, death took place in 6½ hours. The quantity taken would be equivalent to somewhat more than a quarter of an ounce of nitrate of baryta.

Treatment.—The free use of the sulphate of soda or of magnesia as an antidote, emetics, and the stomach-pump. The after-treatment is that proper to the irritants as a class.

* 'Med. Press and Circular,' 1868, p. 447.

CHAPTER VI.

IRRITANT GASES.

1. Nitrous-acid Gas. (See p. 425.)
2. Sulphurous-acid Gas.
3. Hydrochloric-acid Gas.
4. Chlorine.
5. Ammonia. (See p. 433.)

The irritant gases have the common property of irritating and inflaming the eyes, throat, and whole extent of the air-passages, and in a concentrated form may cause fatal spasm of the glottis.

2. *Sulphurous-acid Gas.*

This gas is one of the products of the combustion of common coal, and contributes to the fatal result when coal is burnt in close apartments. It is also the chief cause of the irritating gusts which issue from the baker's oven, and contributes to produce the diseases of the chest to which the London bakers are peculiarly liable.

3. *Hydrochloric-acid Gas.*

From experiments made on plants by Drs. Turner and Christison, and from experiments on small animals by Messrs. Rogerson (see chapter on Poisonous Gases in Christison 'On Poisons'), it is evident that this gas is possessed of highly irritating properties, and that if inhaled by the human subject it would destroy life, as certainly as any other of the irritant gases.

4. *Chlorine.*

This gas is largely used in bleaching, and, in the sick room, as a disinfectant. It produces violent irritation in the eyes, nostrils, air-passages, and throat. In a case cited by Christison, great relief was obtained by the inhalation of a small quantity of sulphuretted hydrogen gas.

From information collected by Christison, it appears that men who are in the habit of inhaling air impregnated with chlorine become gradually accustomed to its use, though they suffer from dyspeptic complaints and acidity, and lose flesh; but nevertheless many of them attain to an advanced age.

THESE two poisons, as well as the
most of the metallic poisons, give
cannot be explained by the intensi
might, therefore, be properly distl
As this statement is sufficient for
not deemed necessary to place the
this and the following chapters.

I. PHOSPH

Properties.—It is usually foun
white, translucent cylinders, prese
sistence and flexibility of wax, an
insoluble in water, but soluble in
form. It is also remarkably so
After being kept some time in
a yellowish-white coating.† Wh
off white vapours of phosphorus
heated or rubbed, burns with a ye
vapours. It is luminous in the d
of garlic. A paste consisting of
and phosphorus, sometimes colou
as a poison for rats; and when
potash, gum, sand, and red lead,
used to tip lucifer matches. It

over-doses; is very often taken in France, and sometimes in England, as it exists on lucifer matches; and has been given in substances and liquids of strong colour and flavour as a poison, or as an aphrodisiac.

Symptoms.—Poisoning by phosphorus is characterized by the variety of its symptoms, and often by their obscure and insidious character. It may occasion three well-defined groups of symptoms—*a. Irritant; b. Nervous; c. Hæmorrhagic.*

a. At the moment of swallowing the poison a disagreeable taste and odour are often perceived, compared by some to garlic, by others to burning sulphur. There is heat and pain in the throat, swelling of the tongue, and sometimes pain in the pit of the stomach, with discomfort and excitement, and nausea, followed often after a considerable interval, by vomiting of matters mucous or bilious, rarely bloody; sometimes shining in the dark. Vomiting, when it occurs, affords relief, but it is often absent. Colic pains and diarrhœa, with some tenderness of the belly, sometimes follow. The countenance undergoes little change of expression, and the mind is intact. At the end of twenty-four or thirty-six hours the vomitings cease, the patient goes about as usual, complaining of wandering pains in the limbs and loins. The pulse is small, soft, and slow. This treacherous calm may last for two, three, or four days, or even more, and when the patient seems to have recovered, he may die suddenly without presenting any new symptoms. But generally, on the second or third day, jaundice shows itself with headache and sleeplessness and retention of urine, which, when drawn off by the catheter, is found tinged with bile, and perhaps albuminous. Vomitings also occur from time to time, and painful, sometimes involuntary, discharges from the bowels. Acute delirium, followed by fatal coma, lasting from six to twelve hours, terminate the case. In many young infants, vomiting, followed by somnolence and convulsions, are the leading symptoms, and death takes place in from four hours to two days.

b. In this form the symptoms in the throat and stomach are attended by creeping sensations in the limbs, painful cramps, and repeated faintings, with extreme prostration and somnolence, but no fever, and no venereal excitement. The skin is dry, yellow, and marked by erythematous spots. About the fifth or sixth day, sometimes later, acute delirium suddenly breaks out, with rigid contraction of the jaw, and convulsions, followed by coma, and death in from a week to a fortnight, rarely later.

c. The symptoms set in as in the previous varieties, but the matters vomited often consist of pure blood, and are succeeded by

...ge of blood by s
or a month, discharges of blood
nose, ears, womb, and bladder;
surface, and blend on the skin a
colour of jaundice. This state c
even as five months. Meanwhile
patient growing more and more s
the end of as many as eight month
just described. When the poison
leave behind it extreme debility,
case by M. Caussé, incurable palsy

Post-mortem Appearances.—W
substance, there are bloody or ga
stomach, and intestines, with sw
mesenteric glands. The coats of t
forated. When the phosphorus is
as in the paste, or on lucifer matc
are such as might occur in the worst
spots in every organ and tissue, b
bloody matters in the intestinal
bladder. The skin has a yellow tin

One of the most marked effects c
the fatty degeneration which it in
organs of the body: in the muscles,
stomach, the kidneys, and, in a mar

The substance of the muscles b
fatty. The heart is similarly af
stomach are altered in colour, and a
fatty epithelium [illegible]

deal, specks of sulphur, or of vermilion or other colouring matter, adhere to the coats of the gullet, stomach, or intestines, or are found among their contents.

Fatal Dose.—One grain or less.

Fatal Period.—In acute cases as little as four hours. In chronic cases, life may be prolonged for several months.

Diagnosis.—When called to a case of poisoning supposed to be by phosphorus, the medical man may be able to ascertain the fact beyond doubt by closing the doors and windows, and examining the mouth and nostrils, person and clothes of the patient, as well as the matters rejected from the stomach or bowels, or things on which they may have been discharged.

Poisoning by phosphorus resembles in many respects the disease known as acute yellow atrophy of the liver. There are, however, certain points of difference. In acute yellow atrophy the marked signs of acute gastritis which in phosphorus poisoning precede the jaundice, are wanting; and cerebral symptoms are more predominant: and though in both conditions there is fatty degeneration of the liver and internal organs, in phosphorus poisoning the liver is usually found enlarged, and the lobules distinct; while in acute yellow atrophy the liver is greatly diminished in size, greasy on the surface, and with the lobules almost obliterated.

In acute yellow atrophy leucin and tyrosin are found abundantly in the urine; while in phosphorus poisoning these products are rarely if ever found, their place being taken by certain peptone-like bodies along with sarcolactic acid. From the researches of Voit and Bauer (see 'Journ. of the Chem. Soc.,' vol. xxiv. p. 946) it would appear, however, that there is no essential difference between the effects of phosphorus poisoning and acute yellow atrophy; the differences observable being due more to the fact that the changes take place more rapidly in acute yellow atrophy than in poisoning by phosphorus. The fatty degeneration caused by phosphorus is attributed to diminished oxidation of fat and increased transformation of the nitrogenous tissues.

Treatment.—Antidote.—The recent researches of Köhler, Vetter, and others seem to prove that in oil of turpentine we possess an efficient antidote for phosphorus, provided it be given in time. There is some difference of opinion as to the kind of oil of turpentine which is most effectual. It would appear that oil of turpentine which has not been rectified, and which has become ozonized by long standing, is the best. Vetter recommends us to begin the treatment with an emetic of sulphate of copper (regarded as a powerful antidote by Bamberger). After the action of the

phorus may often be perceived i
If phosphorus has been taken
matches, it will be seen on inspe
solid sediment, which will becon
heated. If we do not find an
stomach, spread out on a plate
warmed, may become luminous, a
teristic odour is given out. Putre
nosity; but it is concealed by
ammonia. Another method of pr
organic matter with bisulphide of
tion may leave globules of phosp
application of a hot wire.

If no results are obtained by th
ing to more minute analysis, we
It consists in suspending in the
posed to contain the matter impre
of thin filtering paper soaked in
On warming the flask, if phosph
become blackened by the reductio
phosphide. But as blackening m
phuretted hydrogen, it is recomme
nitrate of silver paper a paper satu
the silver paper is blackened, and
is present.

Mitscherlich's Method.—This i
for phosphorus. "To the organic
small quantity of sulphuric acid

that by this means 1 of phosphorus in 100,000 may be detected. The test will be interfered with if turpentine, alcohol, &c., be present.

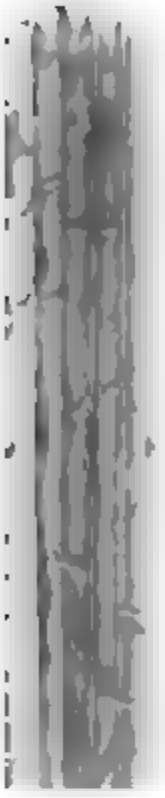
Blondlot's Method.—This is based on the fact discovered by Dussard, that phosphorus and its lower oxidation products in presence of nascent hydrogen combine to form phosphoretted hydrogen, which burns with an emerald-green flame. The application of this test requires an apparatus similar to that used in Marsh's process for the detection of arsenic. (See fig. 86, p. 461.) Hydrogen is generated with pure zinc and dilute sulphuric acid, and the fluid material supposed to contain phosphorus is then introduced through a funnel. If phosphorus is present, the gas issuing from the apparatus burns with an emerald-green flame. Two or three precautions are to be observed in reference to this. It is best to have the nozzle made of platinum, all such metals as copper being avoided. A glass nozzle speedily becomes so hot that the flame, even though phosphorus is present, does not exhibit a green colour. The green colour may be brought out in great brilliancy by shading the flame from the direct sunlight, and pressing on it with a cold porcelain lid. The presence of certain vapours, such as those of alcohol and ether, conceal the colour of the flame. Even sulphuretted hydrogen is said to do so. Blondlot, therefore, instead of igniting the hydrogen issuing from the simple arrangement described, recommends that the gas should be made to pass into a vessel containing a solution of nitrate of silver. If phosphorus is present, a brownish-black precipitate of silver in combination with phosphorus is thrown down. This precipitate is then to be introduced into a Marsh's apparatus as before, when the emerald-green colour will be obtained with great distinctness.

All these methods for the detection of phosphorus are adapted to the discovery of phosphorus itself or its lowest oxidation products. The presence of phosphoric acid would be no indication of phosphorus having been taken as a poison; for phosphoric acid is a normal constituent of the body, and of many articles of food.

Chronic Poisoning by Phosphorus.

The makers of phosphorus, the manufacturers of congreve matches, the makers of some kinds of vermin-paste, and pharmaceutical chemists, are more or less exposed to the vapours of phosphorus. Those who suffer from such exposure waste away

to Reveil, and which avails itself of the ready solubility of phosphorus in bisulphide of carbon, Messrs. Tardieu and Roussin allege that up to this time the only method which can inspire confidence is this method of Mitscherlich. 'Sur l'empoisonnement,' p. 407.



time arrested. More frequently, how
bone becomes denuded, the gums g
the alveoli, the teeth get loose and
becomes more copious, and the dis
soft parts. At the end of six month
the patient sinks from some exhaust
poisoning, or, having lost by degree
the upper or lower jaw, the patien
shocking deformity.*

The discovery of the important
allotropic phosphorus, though posse
position, is not poisonous, may lead
phorus for manufacturing purposes.

II. IODIN

Properties.—A scaly substance,
peculiar and disagreeable odour, yie
when heated, striking a fine blue w
staining the skin and intestinal canal
by liquor potassæ. It is found in t
tincture; and as a compound solutio
for solvent. It is largely used i
application.

Symptoms.—A disagreeable acrid
heat, dryness, and constriction in the

of iodine or its preparations in medicinal doses, added to irritation of the alimentary canal, are catarrhal symptoms, emaciation, tremors, palpitation, gradual absorption of the testicles, mammæ, and other glandular structures, ptyalism, increase of most of the secretions, priapism, and enlargement and tenderness of the liver. These symptoms have been more than once produced by small doses administered for a few days at a time.

Post-mortem Appearances.—Those of acute irritant poisoning, with corrosion (p. 379). Enlargement of the liver.

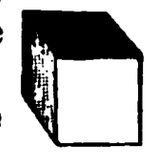
Treatment.—After the stomach-pump, the free use of a weak solution of carbonate of soda, and of diluents containing starch, such as arrow-root.

Iodine in Organic Mixtures.—The poison is readily identified by the characters above given. Bisulphide of carbon which dissolves it readily, yielding a pink solution, has also the property of separating it from some of its solutions, and depositing it again on evaporation.

IODIDE OF POTASSIUM (*Hydriodate of Potash*).

Properties.—A crystalline substance, having a peculiar faint odour; white when pure, permanent in the air, and very soluble in water and alcohol; but when impure, of a yellowish colour, and deliquescent. Crystalline form a cube (fig. 75).

Fig. 75.



Tests.—Strong nitric or sulphuric acid turns the crystals brown, and liberates the iodine, which, on applying heat, rises in violet vapours.

In Solution it has the following reactions:—Corrosive sublimate throws down a fine carmine-red iodide of mercury; acetate of lead, the yellow iodide of lead; the subnitrate of mercury, the yellow subiodide of mercury, which gradually changes to a dirty brown; sulphuric and nitric acids change the solution to a brown; and, on the addition of starch, to a characteristic blue. The base may be detected by the bichloride of platinum.

In Organic Mixtures.—Transmit sulphuretted hydrogen through the mixture to convert free iodine into hydriodic acid. Expel the excess of gas by a gentle heat, add potash in excess, filter, and evaporate to dryness. Place the residue in a covered crucible, and char it at a low red heat; reduce the charred mass to powder, treat it with distilled water, and filter; concentrate by evaporation; and apply the test of starch and sulphuric acid. In this way minute quantities of the poison may be detected.

Symptoms.—When given as a medicine, in small doses, the hydriodate of potash sometimes acts injuriously, through peca-

case, in which I ascertained that no
been given, all the characters of m
sent (G.) Long continued admi
mena of iodism just described.

Treatment.—After the prompt
emetics, or the stomach-pump, di
remedies if necessary.

CHAPTER VIII.

METALLIC IRRITANTS.

I. ARSENIC. II. ANTIMONY. III. MERCURY. IV. LEAD. V. COPPER. VI. ZINC, TIN, SILVER, IRON, BISMUTH, AND CHROME.

I. ARSENIC AND ITS PREPARATIONS.

ARSENIC is by far the most important of the metallic poisons, whether measured by the extent to which it is diffused, its many applications in medicine and the arts, or its use as a poison.

Arsenic and its compounds enter largely into the composition of the earth's crust, as metallic arsenic, arsenious acid, the two sulphides, realgar and orpiment, or as a constituent of several ores of iron, copper, silver, tin, zinc, nickel, and cobalt. Most of the arsenious acid of commerce is prepared from an arsenical sulphide of iron, known as mispickel, or arsenical pyrites; the remainder from the roasting of ores, chiefly of copper and cobalt.

Arsenic has accordingly been found in several soils, and in plants grown in them, and in some mineral waters and running streams. Arsenious acid is largely diffused through the air surrounding some smelting furnaces, and arsenic acid and the alkaline arsenates are used as mordants, in some dye-works to such an extent as to poison the streams into which they discharge their refuse; and even to taint the water-supply of towns.

As the iron pyrites, or *mundic*, largely used in the manufacture of oil of vitriol, contains arsenic, much of the sulphuric acid of commerce is tainted with it; and this being, in its turn, used in the manufacture of nitric, hydrochloric, and other volatile acids, of sulphate of soda, as a preliminary to the making of the carbonate, and for other purposes, many liquid and solid substances in common use in medicine and the arts are impregnated with arsenic. The two metals, zinc and copper, the two acids, the sulphuric and hydrochloric, and the sulphide of iron used in testing for arsenic, have all been found to contain it.

Arsenious acid, the most important compound of arsenic, is

much employed in the arts. It is used in the manufacture of glass, to improve the quality of the "metal," and in making white enamel. Composition candles sometimes contain it. It is used to prevent "furring" in steam boilers. Shipbuilders mix it with tar to protect timber from worms. It is contained in liquids, powders, and papers for killing rats and vermin, flies and moths. Farmers use it to preserve grain for seed, and as an ingredient in dipping-compounds for sheep. Grooms give it to horses to improve their coats, and there is no longer any doubt that some Styrian peasants habitually take arsenious acid in quantities exceeding the smallest poisonous dose.*

The metal arsenic is mixed with lead in small shot.

Preparations of arsenic have been mixed by accident or design with articles of confectionery: arsenious acid with lozenges, orpiment in Bath buns, and Scheele's green with blancmange. This last, or an analogous preparation, is also very largely used in many of the ornamental arts; and arsenic is also used in the preparation of some aniline dyes, in which it may be found in considerable quantity.

Medicines containing arsenic are prescribed for the cure of ague and intermittent disorders, and of obstinate diseases of the skin; and white arsenic, subdivided by mixture with calomel or other suitable vehicle, is applied externally in lupus and cancer.

Arsenious acid enters into two preparations in the British Pharmacopœia, the liquor arsenicalis, or Fowler's solution (gr. iv. in fl. ʒj), and the liquor arsenici hydrochloricus (gr. iv. in fl. ʒj).

Arsenic acid enters into the ferri arsenias, the sodæ arsenias, and the liquor sodæ arsenatis (gr. iv. in fl. ʒj).

The preparations of arsenic most interesting in a medico-legal point of view are, the white oxide or arsenious acid, the yellow sulphide or orpiment, the green arsenite of copper, or Scheele's green, and the arsenite of potash contained in Fowler's solution. Of these the arsenious acid is by far the most important; and must therefore be examined with great care and minuteness.

As all our processes of analysis include the production of the metal arsenic as a means of identification, some account must first be given of its most important properties.

* Dr. Roscoe, in a paper read to the Manchester Philosophical Society, Oct. 30, 1860, brought forward conclusive evidence in support of this statement, and adduced well-authenticated instances in which the poison was swallowed to the amount of 4½ and 5½ grains at a time, and Dr. Maclagan has more recently placed the fact beyond the reach of doubt. See his interesting and instructive paper in the 'Edinburgh Medical Journal,' vol. x. p. 200, and letter from Dr. Knapp bearing witness to the swallowing of 7½ grains of arsenious acid. Ibid. p. 669.

The *metal* arsenic is stated to sublime at 356° Fahr.; but I have found that small quantities of the metal sublime at 230°. (G.) The sublimation gives rise to the odour of garlic. When the process is conducted in close vessels, in an atmosphere of carbonic acid, it settles on cooler surfaces unchanged; but when heated in the air, it is deposited as white oxide, or arsenious acid, or as a mixture of the acid with the metal. In common with antimony it combines with nascent hydrogen to form arseniuretted hydrogen, which gas, when heated or burned, gives up the pure metal to cooler surfaces; and it shares with several other metals the property of being reduced and deposited on copper boiled in an acid liquor containing any of its preparations.

All these properties of metallic arsenic are displayed in operations on the small scale with the spirit-lamp and reduction-tube. The vapour of the metal has the garlic odour: it is deposited as arsenious acid, when the tube contains atmospheric air; and as pure metal when it is filled with carbonic acid gas: it forms a shining metallic crust, or stain, on white porcelain when the burning jet of arseniuretted hydrogen is directed upon it from Marsh's apparatus; it leaves a similar stain in the tube through which the gas is transmitted, when it is heated by the spirit lamp; and it gives a metallic coating to copper foil boiled in liquids acidulated with hydrochloric acid, as in Reinsch's process. The vapour of the pure unmixed metal is deposited on cooled surfaces as minute globules, which shine by reflected light like those of mercury (fig. 76); but when there is enough air present to oxidize part of the vapour, the globules of metal are blended with the white powder or brilliant crystals of arsenious acid.*

Fig. 76.

ARSENIOUS ACID (*Oxide of Arsenic, Sesquioxide of Arsenic, White Oxide of Arsenic, White Arsenic, Arsenic.*†)

In the two years 1837–38, arsenious acid was the ascertained cause of 185 deaths, being as many as those attributed to all the preparations of opium, and many more than those caused by all other poisons. Of these 185 deaths, 112 were ascertained to have been suicidal, 21 accidental, and 12 homicidal; but the last figure is certainly too low.

Since the act of 1851 (14 Vict. cap. xiii.), which restricted the sale of arsenic, and prescribed its admixture with soot or indigo

* Refer to a paper by Dr. Guy, 'On the Production and Identification of Crystals of Arsenious Acid and Crusts of Metallic Arsenic,' in Dr. Beale's 'Archives of Medicine,' No. 111, 1858.

† In some country places it is known as "Mercury\"

still higher rank as a poison.

This common use of arsenious a surprise; for it is as white as flou be mixed with articles of food with change, is very cheap, and is largel great variety of purposes.

Arsenious acid is found in comm powder. The cake, when first ma but in time becomes opaque, resemb transparent strias. It is the powde poison. Arsenious acid, in both thes sical properties, and may be readily

***Properties.*—1. Sparingly soluble solution has a very slight acid reac less, but its solution or vapour ha 4. The aqueous solution slowly ev crystals. 5. Very soluble in ammoni bonate of potash; and deposited fr and hydrochloric acid, also as oct alkalies, forming soluble arsenites.** ***solubility*, must be more minutely ex**

***Solubility.*—An ounce of cold w grain to a grain; boiling water pou cooling a grain and a quarter to the an hour on the powder 12 grains to** organic matter renders the poison les

Tests.—We may have to identify

2. *In solution* 3. *In organic l*

deposited as an amorphous powder, or as octahedral crystals. *c.* Moistened by liquor potassæ it undergoes no change of colour. *d.* Moistened by sulphide of ammonium, no immediate change takes place; but when the excess of ammonia has evaporated, been dissipated by heat, or neutralized by acetic acid, a canary-coloured sulphide of arsenic remains. *e.* When arsenious acid mixed with charcoal is dropped into a reduction-tube and heated, the metal is reduced and volatilized, and deposited on the cooler part of the tube as a shining metallic crust. *f.* The sublimed metal has the odour of garlic.

The two tests of sublimation and reduction must be more exactly described, and their results minutely examined.

Sublimation.—It has just been stated that arsenious acid dropped into a reduction-tube and heated by the flame of a spirit-lamp, becomes a white vapour, which deposits on the cooler part of the tube an amorphous powder, or octahedral crystals. But as the crystals are characteristic of the poison, not the white amorphous deposit, it should be well understood that in order to get characteristic crystals the white vapour must be received on a heated surface. On a cool surface it is deposited as an amorphous powder.

The process of sublimation is usually performed in a reduction-tube of about the size and length shown in fig. 79, p. 455. After drying the tube by passing it repeatedly through the flame of the lamp, the arsenious acid, placed in a short tube of smaller size, is dropped in, and the flame of the lamp applied, so as to envelope the lower third of the tube. By the time that the inner tube is so heated as to sublime its contents, the temperature of the outer tube will be favourable to the deposit of distinct crystals.

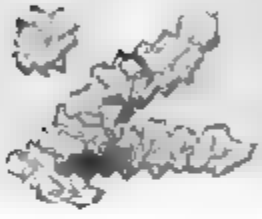
The subliming temperature of arsenious acid is variously stated at 370° to 400° Fahr., but I have ascertained, both by the method explained at p. 406, and by placing fragments of arsenious acid in small reduction-tubes and plunging them into a sand-bath with the thermometer, that the real subliming point is at or about 280° Fahr. (G.)

The crystals of arsenious acid obtained by this coarse method of sublimation also result from the oxidation of the metal arsenic, as a constituent part of tests yet to be described; and as these crystals always furnish a very important means of identification, their shape and characteristic properties should be well understood.

The Crystals of Arsenious Acid are remarkable for brilliancy and permanence. They are almost always distinct and separate, except when superimposed; occasionally they are grouped in

rings; but they rarely form compound crystals of any definite shape. The crystals depicted in fig 77 are extremely uncommon. They were obtained by sublimation in a small tube; and resemble the compound crystals of alum. They were probably first dissolved in the moisture of the tube, and then deposited afresh.

Fig. 77.



The prevailing form of crystal is the regular octahedron. The rhombic dodecahedron, rectangular prism, and plates of various shape and thickness, are less common forms. For an account of the microscopic appearances of the entire crystals, the half crystals, the nuclei or twin crystals, and other exceptional forms, see p. 409 et seq.

Sometimes (probably from insufficient heat) all the crystals assume irregular and confused forms, and some few specimens consist almost wholly of the deep triangular plates which have been mistaken for *tetrahedra* (a form that never occurs), while in others again plates of every size, shape, and thickness abound.

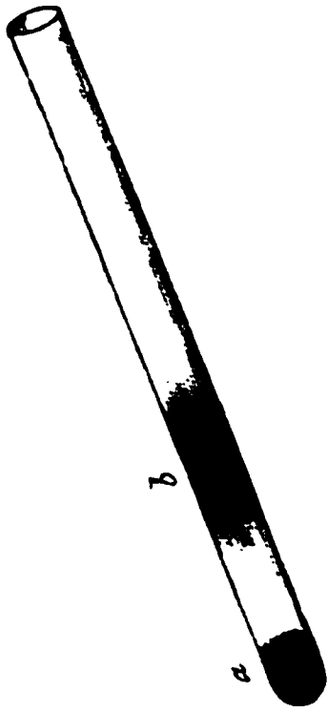
Fig. 79.

Some of the many forms which the crystals of arsenious acid assume are shown in fig. 78, as well as in figs. 81 and 82, where they are mixed with scattered globules of metallic arsenic; also in the mixed crust of arsenious acid and metallic arsenic, as seen by reflected light in fig. 80.

Reduction.—Arsenious acid, well mixed with about four times its bulk of finely powdered recently ignited charcoal, is introduced into the tube, fig. 79, at *a*, with the precautions described in speaking of the process of sublimation, only that it is not necessary to heat the middle portion of the tube. The tube being held at an angle, and the flame of the spirit-lamp steadily applied at *a*, the metal rises in vapour, with the odour of garlic, and is deposited from a quarter to half an inch above the mixture, as a dark brown or black ring, *b*. As the vapour quickly attracts oxygen from the air, it is readily oxidized: so that the ring is always a mixture, in variable proportions, of metallic arsenic and arsenious acid; the metal chiefly at the lower part of the ring wearing the appearance of a mirror; the middle portion containing a large admixture of arsenious acid; and the upper part consisting almost wholly of it. By cautiously applying the flame

of the lamp to the lower part of the ring, it may be rendered more compact and more distinctly metallic; and by driving the crust repeatedly up and down the tube, it may be wholly converted into crystals of arsenious acid.

Fig. 79.



When this reduction is performed with proper precautions (using a tube of green or German glass*), taking care that the mixture of arsenious acid and charcoal, and the tube itself, are free from moisture, so that the mixture may not be driven up into the tube; taking equal care to introduce the mixture so as not to soil the tube; very satisfactory results are obtained. The mixed crusts cannot be mistaken for globules of mercury; nor for the crust obtained by the same process from the white hydrated oxide of cadmium, as the anhydrous oxide of cadmium blended with the crust has a brown, green, or yellow colour.

But as it might be alleged that the crust obtained by this process of reduction does not present such distinct characters as to justify a witness in affirming that it is due to arsenic and to nothing else, we proceed to obtain the crystals of arsenious acid in one of two ways. The sealed end of the tube containing the residue of the charcoal is drawn off, and the metallic crust driven up and down the tube till it is wholly changed into crystals of the oxide; or the sealed end of the tube, as well as the part free from deposit, are filed off, and the part containing the crust, being folded in paper, is broken into small fragments, which are introduced, with like precautions, into a second reduction-tube, and the crust converted into arsenious acid by heat.

But this mode of procuring a crust of metallic arsenic from arsenious acid and charcoal, and crystals of arsenious acid from the crust itself, is open to two classes of objections. The method itself is wanting in delicacy, and encumbered by precautions; and the results present themselves in a form very unfavourable for examination by the lens and microscope, especially when we are dealing with very small quantities of the metal or its oxide. These objections are obviated by the use of the simple apparatus (fig. 48) described at p. 404.

The mixture of arsenious acid and charcoal is first dropped into

* This is to guard against the possibility of the lead which enters into the composition of the more fusible English glass being reduced in the glass itself.

the clean and dry specimen-tube (*a*); the disk of glass (*c*) is dried in the flame of the spirit-lamp, and placed over the mouth of the tube, and the point of the flame is then steadily applied to the bottom of the tube. The vapours of the metal when first disengaged combine with the oxygen of the air contained in the tube, and arsenious acid is re-formed, and deposited on the under surface of the glass disk, as an amorphous powder, or in glittering crystals, according to the temperature. The after-deposit may consist of globules of the metal.

The crust in this case, then, as in the usual process of reduction, is a mixture of metallic arsenic and arsenious acid, and when examined by the lens, or microscope, by reflected light, has the appearance shown in fig. 80, where the sparkling triangular facettes of the octahedral crystals of arsenious acid are shown projecting through a layer of metal. A third form assumed by some of the thinner crusts, and by the circumference of the thicker ones,

Fig. 80.

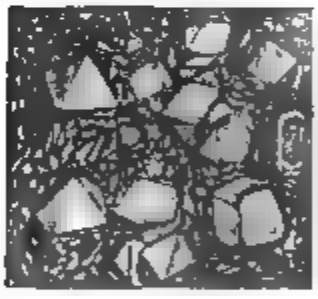
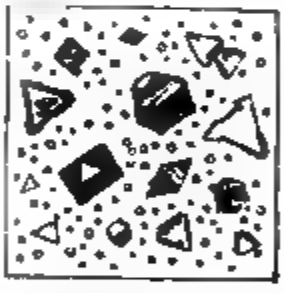


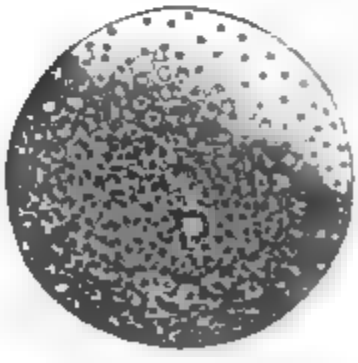
Fig. 81.



consists of crystals of arsenious acid interspersed with distinct globules of metallic arsenic, as in figs. 81 and 82. The thinnest crusts of all are iridescent, and may be resolved, under

Fig. 82.

Fig. 83.



the higher powers of the microscope, into aggregates of small globules. Crusts of pure unmixed metal, presenting under the

microscope the appearances shown in fig. 83, may be readily obtained by covering the mixture of arsenious acid and charcoal with a layer of dried bicarbonate of soda, so as to fill the tube with an atmosphere of carbonic acid gas. See also fig. 76, p. 451.

The appearances shown in figures 80, 81, and 82, prove conclusively the presence of arsenic. Those presented by the unmixed metal in fig. 83 are less conclusive, as the globules are sometimes not to be distinguished from those of mercury. Hence it may be necessary in the case of the purer crusts of arsenic, and expedient in other cases, to confirm the evidence afforded by the microscopic characters of the metallic or mixed crust, by converting the metal into arsenious acid. With this view the portion of glass bearing the crust should be cut into narrow slips with a writing diamond, and the slips being dropped into a specimen-tube (fig. 48), must be treated in the manner just described. The glass disk will be covered with glittering crystals, or with a mist which can be resolved, under the higher powers of the microscope, into groups of octahedra.

It may be well to state that the metals cadmium, selenium, and tellurium are also sublimed by the heat of a spirit-lamp; that selenium is deposited as globules, and tellurium sometimes converted into crystals of telluric acid. But crusts of selenium have the colour of port wine, the crystals of telluric acid are needles, and the metallic crusts of cadmium and tellurium are not globular: so that the mixed crusts of arsenic cannot be confounded with any other result of sublimation.

There is still one method of procedure specially applicable to minute quantities of arsenious acid. If, on evaporating on a porcelain slab a drop of liquid supposed to hold arsenious acid in solution, a white amorphous, or obscure crystalline stain is left, we may test it in one of two ways.

1. By the simple process described in p. 405 (fig. 50).

On heating the porcelain slab, a mist will settle on the heated superimposed disk of glass, which, when examined by the microscope, will be found to consist of crystals of arsenious acid. In this way $\frac{1}{1000}$ grain arsenious acid may be identified without difficulty, and even $\frac{1}{5000}$ grain be found to yield characteristic results.

2. Take a fragment of microscopic glass, and mark it with a writing diamond, so that when broken it may yield narrow slips. Place a drop of the solution on the glass, let it dry, and then break the glass. Introduce the slips into the tube (fig. 51, p. 405) in the manner described, and proceed according to the instructions given. The narrow part of the tube will contain

second to the mixture of arsenious
method the stain will be sublii
acid: by the second a crust will
which will generally be found to
second of crystals of arsenious aci

2. *Arsenious Aci*

There are several tests for ar
applied as liquid, and known as *l*
guished as the *gaseous test*; a fi
test; and a sixth the now equall

1. *The Liquid Tests.*—These
ammonio-nitrate of silver, the a
sulphuretted hydrogen water.
This throws down a rich yellow
posure to light, changes to ding
of copper‡ causes a precipitate
copper. *c.* Sulphuretted hydrog
sulphide of arsenic. The sulph
immediate effect, but after a lo
of a few drops of acetic acid, cau

These tests are supposed to be
colourless liquid believed to cont
are free from objection; but it
tion of phosphoric acid yields wi
yellow precipitate, as an alkaline

and that a decoction of onions gives with the copper solution a green precipitate. As these liquids are only used as trial tests, or to prove that a white powder or colourless crystals obtained from the oxidation of a ring of metal really consist of arsenious acid, these facts do not constitute an objection to the tests.

Gaseous Test.—This test, too, is supposed to be applied to a clear colourless liquid. Having ascertained that it has no decided acid or alkaline reaction, we slightly acidulate with acetic acid, and transmit the sulphuretted hydrogen gas through the liquid. If it contains arsenious acid, it soon assumes a rich golden yellow tint. If the quantity of the poison is considerable, a precipitate of the same colour is formed; but if it is in small quantity, the precipitate is not formed till the excess of gas has been expelled by heat, and the liquid has been left at rest for several hours. The only other substances which yield with sulphuretted hydrogen a yellow precipitate are the peroxides of tin and cadmium, both of rare occurrence, and easily distinguished. The sulphide of antimony is orange-coloured. The presumption, therefore, is strong in favour of arsenic, and may be converted into certainty by collecting and testing the precipitate, or by applying the ammonio-nitrate of silver and the ammonio-sulphate of copper to other portions of the same liquid.

The precipitated sulphide of arsenic having been allowed to subside, is to be carefully collected, washed, and dried, and submitted to a process of reduction differing from that already described when speaking of arsenious acid only in the substitution for charcoal of a flux containing an alkali. That usually employed is the *black flux* formed by incinerating a mixture of one part of nitrate of potash with two of the bitartrate. But incinerated acetate of soda, or a mixture of one part of cyanide of potassium with three parts of carbonate of soda, previously well dried, is to be preferred. If this last flux is used it should be in the proportion of one of the sulphide to twelve of the flux. The metallic crust obtained by this process of reduction is found to be a mixture of metallic arsenic, arsenious acid, and undecomposed sulphide.

In dealing with minute quantities of the sulphide, the method of reduction by the capillary tube (fig. 51, p. 405) should be employed, followed, if the quantity be sufficient, by that described at p. 404 (fig. 48).

The sulphides of cadmium and tin are thrown down immediately by sulphide of ammonium, but the sulphide of arsenic not till the ammonia has been dissipated, or neutralized by an acid. The sulphide of arsenic is very soluble in ammonia, those of

cadmium and tin insoluble, the sulphide of arsenic yields a distinct metallic sublimate, while the sulphide of tin yields none, and the sulphide of cadmium gives the sublimate described at p. 455.

When the precipitated sulphide is not pure in colour or free from organic matter, it should be dissolved in ammonia, and again thrown down by hydrochloric acid.

The gaseous test, properly applied, and followed by the reduction of the metal from the sulphide, gives certain evidence of arsenic. It is unnecessary, though for medico-legal purposes desirable, to convert the sublimed metal into crystals of arsenious acid.

Marsh's Test.—This ingenious and valuable test was proposed by Mr. Marsh, of Woolwich, about the year 1835. He employed two forms of apparatus; the one (fig. 84) consisted of a tube bent in the shape of the letter J, the long leg being twice the length of the shorter one, and open, and the latter furnished with a stop-cock terminated by a nozzle with a minute bore. Hydrogen was generated in this apparatus by pure zinc and dilute sulphuric acid, to which a portion of the liquid containing arsenic was added. When the arseniuretted hydrogen had filled the smaller leg of the tube the stop-cock was opened, and the jet of gas inflamed. On holding over the flame a piece of glass or porcelain, a distinct metallic ring was deposited upon it. For larger quantities of liquid Mr. Marsh used the apparatus depicted in fig. 85.* Many alterations and modifications of Marsh's apparatus have been since suggested, of which fig. 86 represents by far the most convenient form. It consists of a wide-mouthed bottle with a closely fitting cork, pierced for two tubes, of which the one, furnished with a funnel, dips beneath the liquid, the other bent nearly at right angles, but sloping slightly towards the bottle, descends a short distance into the vessel. This tube is furnished with a cork for the reception of a detached horizontal tube of

Fig. 84.

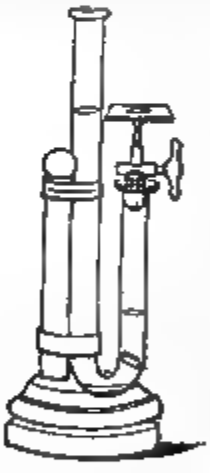
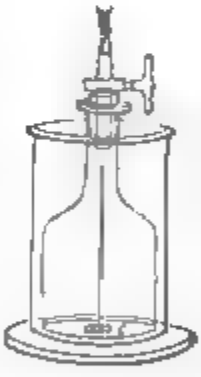


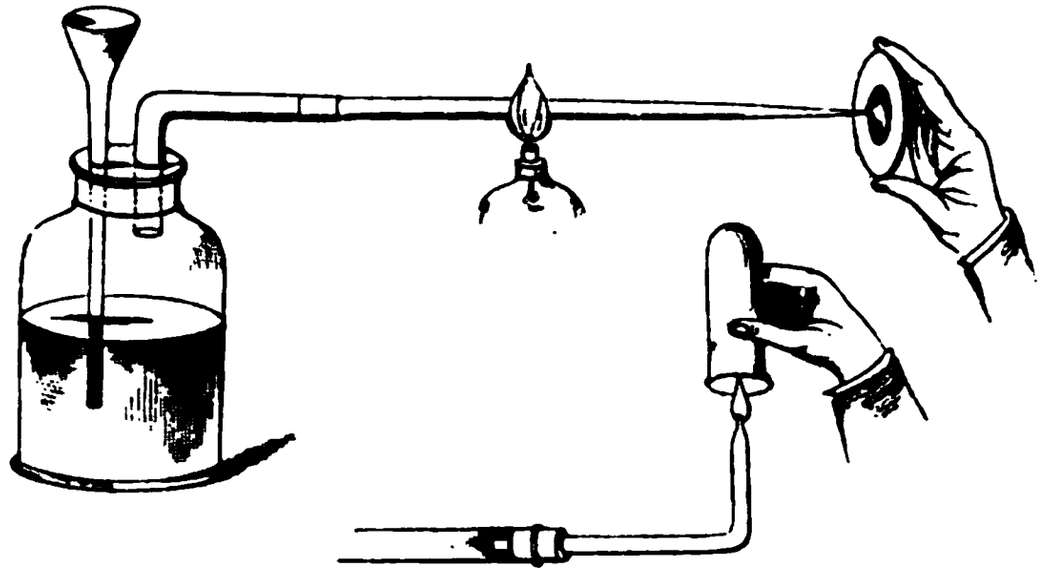
Fig. 85.



* For an account of the apparatus employed by Mr. Marsh, and the results obtained, refer to the 'Transactions of the Society of Arts,' vol. ii. 1835-6.

glass free from lead, and drawn out into a point with a small aperture.

Fig. 86.



In this apparatus hydrogen is generated by pure zinc and dilute sulphuric acid, and the action is continued till the atmospheric air is completely expelled, and all risk of an explosion avoided. The flame of a spirit-lamp is then steadily applied for ten or fifteen minutes to the horizontal tube. If there is no deposit we conclude that the zinc and sulphuric acid do not themselves contain arsenic. Having ascertained this, we pour into the funnelled tube part of the liquid supposed to contain arsenious acid, and immediately reapply the spirit-lamp to the horizontal tube. If the liquid contain arsenious acid, a metallic deposit takes place in the tube half an inch or more from the part to which the flame is applied. The horizontal tube should be five or six inches long, so that we may obtain two such crusts at least. Having procured these, we light the hydrogen as it issues from the end of the tube, and obtain one or two deposits on slips of porcelain, and others on disks of crown glass. A very minute quantity of arsenic suffices for both these purposes. We may then continue to apply the flame of the lamp to the horizontal tube, till the absence of stain from a fragment of glass held before the jet proves that the metal is exhausted. The spots thus obtained consist either of arsenic or of antimony.

The evidence afforded by the stains thus obtained may be confirmed by bending the horizontal tube at right angles and holding a wide test-tube over the flame (fig. 86). The tube will be coated with arsenious acid resulting from the oxidation of the metal, and to its contents, dissolved in a small quantity of distilled water, we may apply the liquid tests.

The round stains on the surface of porcelain have the following distinctive properties:—

a. The arsenical stain has every variety of metallic lustre, from that of copper to that of steel, but it never wears the sooty appearance proper to most crusts of antimony. *b*. The arsenical stain is much more readily dissipated by the heat of the spirit-lamp, and gives out the garlic odour.* *c*. The two stains are characteristically affected by several liquid and gaseous reagents, from which we select three, the first two as tests by simple solution, the last as a test by solution followed by a characteristic coloured residue. The first of these tests was suggested by Bischoff, the second by Dr. Guy ('Medical Times,' July, 1847), the third also by Dr. Guy in a former edition of this work.

1. The arsenical stain is rapidly dissolved by a solution of the chloride of lime (bleaching liquid), which does not affect the antimonial stain. 2. The antimonial stain is less speedily, but at length completely dissolved by a solution of the protochloride of tin, which does not dissolve the arsenical stain. 3. The antimonial stain is rapidly dissolved by the sulphide of ammonium; the arsenical stain slowly and imperfectly. The solution of the antimonial stain, when dry, leaves an orange-coloured spot of sulphide of antimony, while the imperfectly-dissolved arsenical stain presents a light lemon-yellow spot of sulphide of arsenic mixed with portions of undissolved metal.

Should the stain contain both antimony and arsenic the chloride of lime will dissolve out the arsenic, and leave the antimony. So, on the other hand, the protochloride of tin will dissolve the antimony, and leave the arsenic.

The arsenical stain, as it usually contains some arsenious acid, may be tested directly by the ammonio-nitrate of silver in the following simple way: Add to the stain a drop of nitrate of silver solution, with a glass rod (slightly stirring), and then blow the vapour of ammonia upon it. The lemon-yellow arsenite of silver will be immediately formed.

The larger and thicker stains of arsenic may also be readily identified. Globules of metallic arsenic may be seen by the higher powers of the microscope on the disks of glass (fig. 83), or they may be transferred from the slab of porcelain to a glass

* This test may be applied as follows:—Procure a crust of arsenic and one of antimony on the ends of two oblong porcelain slabs. Obtain two stains at the other ends of the slabs from the liquid under examination, apply the flame of the spirit-lamp steadily to the centre of the porcelain between the two stains. If there is an arsenic stain at one end, and an antimony stain at the other, the first will soon contract under the heat, and ultimately disappear, before the other shows any signs of being affected by it.

disk by the method described at p. 405, and illustrated in fig. 50). The glass disk will be found covered with octahedral crystals; or, if the cell is very shallow, with globules of the metal, or the two combined.

The stains of antimony and arsenic in the tube also present some remarkable differences. The antimony is deposited close to the point to which the heat is applied, and on both sides of the flame (A, fig. 87); the arsenic at some distance from it (B, fig. 88). When heated, the antimony volatilizes very slowly, the arsenic quickly; the arsenic has often a nut-brown or copper colour, the antimony the lustre of tin. Of these properties the first and second are highly characteristic; but the colour of the crusts is less constant; for though antimony rarely presents the distinct

Fig. 87.
A

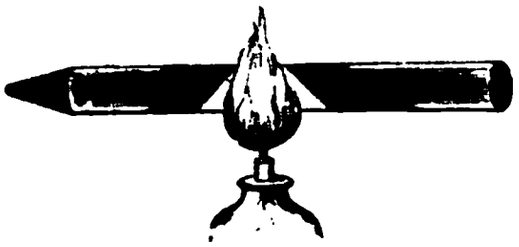
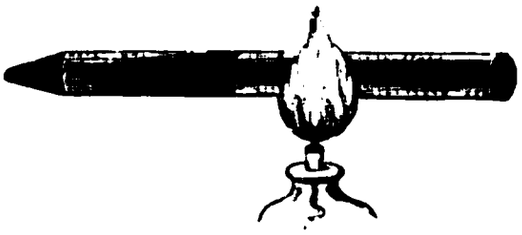


Fig. 88.
B



copper colour of arsenic, nor arsenic the tin-like lustre that belongs to most crusts of antimony, crusts of antimony and arsenic may happen to resemble each other in colour, though not in shape or position. The effect of heat is decisive; for while the crust of antimony moves slowly under the flame of the spirit-lamp, and undergoes no remarkable change, the crust of arsenic is easily dissipated, and readily converted into characteristic crystals of arsenious acid. The crusts of arsenic and antimony may also be readily distinguished by detaching the horizontal tube, transmitting a stream of dry sulphuretted hydrogen gas through it, and chasing the metal, by the flame of the lamp, in a direction opposite to the stream of gas. The antimonial crust changes its place very slowly, and gradually assumes, but only in part, the characteristic orange hue of the sulphide; while the stain of arsenic is readily driven from point to point as a light lemon-yellow crust of sulphide.

Some precautions are necessary in using Marsh's test. To guard against explosion, the gas should be generated freely at first, but less briskly when adding the suspected liquid; for the smallest addition of another metal occasions a violent extrication of gas. The first violent action having subsided, the jet should be lighted; and the absence of arsenic (in other words the purity

A few [illegible] also be [illegible]
If [illegible] happen to [illegible]
[illegible]

Reinsch's Test. [illegible]
tube, and add about the eighth of
acid, drop into the tube a narrow s
and heat the liquid to the boiling p
speedily tarnished by the liquid, ot
one by one, until the copper retai
then to be removed, washed in disti
temperature. The metal arsenic wi
grey coating, adherent if in small q
if more copious. A single slip if t
if merely stained) is then to be
reduction-tube (fig. 51), with the p
Minute crystals of arsenious acid,
microscope, will be found in the ea
characteristic results are obtained b
be similarly treated in the manner
trated in fig. 48, or by the meth
fig. 50, p. 405. The crystals of a
surface, can be readily examined by

By either of these methods satis
tained with the $\frac{1}{1000}$ grain of arsen
tised hands with the $\frac{1}{5000}$ grain.*

Certain precautions must be take
hydrochloric acid may contain arsen
even many of those thrown down by

It is only when the liquid which is being tested dissolves the copper, that the impurity of the metal can interfere with the result. In order, however, to guard against both fallacies and objections, a copper of ascertained purity should be used.

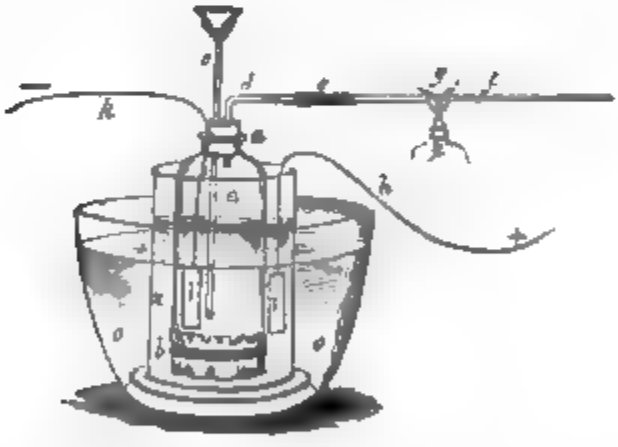
The process of sublimation which constitutes the second part of the test is necessary because other metals as well as arsenic yield metallic deposits: solutions containing mercury and silver without boiling, and those containing antimony, bismuth, tin, and lead, on applying heat. Alkaline sulphides also tarnish the metal.

These metallic deposits differ in appearance; but not so as to dispense with the use of further tests.

That these and similar statements respecting the detection of minute quantities of arsenic, or of other poisons, may not be discredited, refer to what is said on this subject at page 400.

Galvanic Test.—Our colleague, Professor Bloxam, advocates the method of electrolysis as the least objectionable means of generating arseniuretted hydrogen and procuring crusts of metallic arsenic. He first made use of a simple modification of the J-tube fig. 84, p. 460, but afterwards preferred an apparatus of the form shown in the annexed engraving, in which *a*

Fig. 89.



is a two-ounce bottle, the bottom of which is replaced by vegetable parchment *b*, secured by thin platinum wire. The cork *a*, carries a funnelled tube *c*, a small tube *d*, bent at right angles, and connected by a caoutchouc tube *e*, with a drawn-out reduction-tube *f*; and it is pierced by a platinum wire *k*, suspending a plate of platinum-foil *l*. The wire is connected with the negative pole of a galvanic battery. This bottle is placed in a glass *n*, a little larger than itself, and into which the positive plate *i*, attached to the wire *h*, of the battery is introduced. The apparatus is placed in a larger vessel, o o, filled with cold water.

[illegible] of Marsh's apparatus.

This method supersedes th
[illegible]
[illegible], and it is very delicate.
series of experiments with qu
from the $\frac{1}{100}$ to the $\frac{1}{1000}$ grai
the alliaceous odour, and a shi
acid, being obtained in each i
that in generating hydrogen i
apparatus, zinc may be replaced
the impurities sometimes found

3. *Arsenious Acid*

As arsenious acid is very inso
in organic liquids, the poison
solid form by diluting with d
powder to subside. It may also
coat of the stomach, from which
arsenious acid obtained in the
manner described at p. 452.

If there is no solid arsenious
poison may still be diffused th
which case the liquid must b
liquor potassæ, and then careful
water-bath. By this means

poison is considerable. In other cases the process presently to be described must be employed. The solid matters that remain on the filter must be preserved, so that if we fail to procure evidence of arsenic from the filtered liquid, it may be treated by the methods now to be described as applicable to the solids and fluids of the body.

4. *Arsenious Acid in the Solids or Fluids of the Body.*

As there are cases of poisoning by arsenic, in which the poison is entirely expelled during life, so that no trace of it can be found in the stomach after death, it is most important to be able to detect it in the fluids or solids to which it has been conveyed by absorption.

All the methods which have been proposed for effecting this object consist of three essential parts:—The destruction of the animal matter so as to obtain a liquid which will pass the filter; the reduction of the poison to the metallic state by Reinsch's or Marsh's method, or by electrolysis, and the complete identification of the metal.

For the destruction of the animal matter four principal methods have been proposed—by nitrate of potash; by nitric acid; by sulphuric acid; and by hydrochloric acid. The last of these methods is recommended by its simplicity, as well as by the fact that the acid employed is the same that is used in Reinsch's test.

The following process, proposed by Fresenius and recommended by Professor Bloxam, has the great advantage of presenting the poison in the convenient and manageable form of arsenious acid.

If the organic matters are solid, they must be finely divided and brought to the consistence of thick gruel by mixture with water. If already in a liquid state, we proceed at once to digest them for an hour, in a porcelain dish over a water-bath with about half an ounce of hydrochloric acid, adding powdered chlorate of potash occasionally till the organic matters are disintegrated. The resulting coloured liquid is then to be filtered off, evaporated over the water-bath to about an ounce, poured into a flask, and a few drops of a strong solution of bisulphite of soda added till it smells strongly of sulphurous acid. The flask is then heated in a water-bath until this odour ceases. The resulting solution, mixed with at least an equal bulk of water, may be examined for arsenic by the methods already described.

Quantitative Analysis.—The quantity of arsenious acid is best determined by the use of the pure sulphide obtained from a measured portion of the filtered liquid: 100 grains of sulphide nearly correspond to 80 grains of arsenious acid.

necessary to analyse a portion o
are first treated with boiling wat
by evaporation to a convenient
process. If this gives no indicati
soil is treated with one part of h
The lime and iron dissolved by
adding bicarbonate of potash in
filtered and reduced as before, is

The following facts bearing on
detection of arsenic in the dea
mind:—

a. Arsenic may be detected in
intervals of time as seven and
usually found attached to the ex
white powder or paste, is convert
the sulphuretted hydrogen gene
parations of arsenic preserve dea
good reason for believing that
affirmed that arsenic is a natural
e. Arsenic when contained in the
if not always, in an insoluble for
lime. *f.* Preparations of arsenic
doses, or in repeated small ones, a
may be found in the textures and
slowly eliminated from the body
the complete elimination of arseni
weeks; but it has been extended t

violent beating of the heart, frequent pulse, quick catching respiration, extreme restlessness, great debility, cramps in the legs, and convulsive twitchings in the extremities. In the majority of cases the mind is intact. When the poison proves rapidly fatal, death commonly takes place by collapse, or by coma; in more chronic cases, the patient dies exhausted by the violence of the irritative fever, or after a long train of nervous symptoms terminated by convulsions. Patients who recover are either restored to perfect health, or they suffer from indigestion, from prolonged weakness or palsy of the limbs, or from epileptic fits.

But cases of poisoning by arsenic present the greatest possible variety in the character, combination, and severity of the symptoms, and exceptions and anomalies of the most perplexing kind.

In one considerable class of cases, the symptoms are those just detailed in an aggravated form. The vomiting is incessant; the pain in the pit of the stomach most acute, and increased by the slightest pressure; the mouth, tongue, and throat are red, hot, and swollen; the eyes bloodshot; the countenance flushed; the thirst excessive; the diarrhœa profuse, and attended with tenesmus and discharges of blood; the belly acutely painful and tender, and much swollen; the urine suppressed or passed with pain and difficulty; the pulse full, quick, and frequent; and the respiration laborious and painful; there is a sense of fulness and oppression at the heart with violent palpitation; intense headache, with giddiness, incessant restlessness, and severe cramps in the legs and arms, followed, if life is prolonged, by convulsions, tetanic spasms, epileptic fits, delirium, coma—a group of nervous symptoms varying with each case, and terminating in various ways, and at various intervals, in recovery or death.

In a second class, the symptoms are those of collapse. There is little or no pain, vomiting, or diarrhœa; a cold and clammy skin; extreme prostration of strength; very frequent and almost imperceptible pulse, or one as low as thirty or forty beats in the minute. The mind, as in most cases of arsenical poisoning, is unimpaired, but there is some approach to coma, slight cramps or convulsions, and death without reaction, usually in four or five hours, rarely beyond twenty hours. Sometimes this state of collapse is accompanied by constant vomiting and profuse purging.

In a third class of cases the patient falls into a profound sleep, deepening into coma, and dies in a few hours without rallying. Such a case is reported by Mr. T. Wright, of Dublin. Death took place in four hours, and followed upon sound sleep; and after

cue Duke of Praslin.

All these varieties occur under poison, and are not accounted for by it is administered. The same dose may give rise to prolonged vomiting collapse in a second, to coma in a and severe nervous symptoms in forms may even run into, and be b

Though these varieties do not a they become more intelligible when an irritant to the alimentary canal the symptoms, local and remote, v pain and tenderness, vomiting and that it is absorbed into, and circulat in this manner its specific effects alimentary mucous tract, and not on of the poison in causing pain an purging, but superadding redness an intense thirst, palpitation and rapi nervous system both by its direct a it comes in contact, and by being through the nervous centres, hence sions, tetanic symptoms, epileptic paralysis; and that, lastly, it is in c system through the secretions of t giving rise in one person to jaundic even suppression of urine with its tainted with urea, and coma as a

every other marked symptom, has been wholly absent.) The *vomited matters* consisted, in 3 cases, of blood; in 2, of mucus tinged with blood; in 1, of mucus only; in 1, of water containing arsenic; in 1, of bile, and in 1, of bile and fæces. (The vomited matters are sometimes described as yellow or brown.) *Diarrhœa* present in 11 cases, but absent in 4; in 7 cases excessive. The *matters passed by stool* consisted, in 3 cases of blood, and in 2 of a material closely resembling green paint. *Pain*, present in 19, and altogether absent in 1; in 2 instances it subsided after a short time, and it is stated not to have been increased by pressure in 2 instances. The *tongue and throat* sore, constricted, hot, painful, and tense, in 9 cases. *Thirst:* present in 15, and absent in 2; in 13, described as intense. The *countenance* flushed and swollen in 7 cases; pale and anxious in 5: the facies hippocratica present in 1. The *eyes* inflamed, swollen, or smarting in 7 cases. The *skin* hot and dry in 6 cases; covered with cold perspiration in 4; profusely perspiring, with petechiæ, in 3; universal desquamation in 1; covered with an eczematous eruption in 1. *Headache* in 9 cases, absent in 1; described as intense in 4. Violent *palpitation* in 2 cases. *Pulse* generally very frequent, but of variable character, ranging from 90 to 140, or more; in one case 30 to 49. Jaundice, suppression of urine, strangury, and salivation must be added to this list of symptoms. *Nervous Symptoms.*—Extreme *restlessness* in 5 cases; extreme *debility* in 10; *coma* in 3 cases; *delirium* in 3. The *mind* unimpaired in 6 cases; *cramps* in the legs in 9 cases, in 4 extending to the arms; *convulsions* in 6 cases; *paralysis* of tongue and gullet in 3 cases; *tetanus* in 2 cases; *chorea* in 1; *hysteria* in 1; *epilepsy* in 2. Tetanus, coma, and delirium successively in 2 cases. *Death* took place in 3 cases in the midst of convulsions, and in one after a horrible fit of convulsive laughter followed by rigid spasms of the whole body.

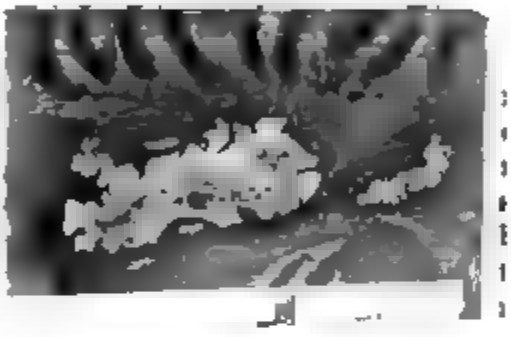
Locked jaw has been observed among the early symptoms—in one case so early as three-quarters of an hour. (Orfila.)*

* The reader is referred to the following cases:—Messrs. Turner, and Mr. Gadsden, poisoned by Eliza Fenning, in Mr. Marshall's Remarks on Arsenic; those of the Mitchells, reported by Mr. Alexander Murray, in the 'Edin. Med. and Surg. Journal,' vol. xviii. p. 167, and three cases given by Mr. Alexander McLeod, in the same Journal, vol. xv. p. 533. These cases afford excellent illustrations of the nervous symptoms which follow poisoning by arsenic. Also 'Ed. Med. and Surg. Journal,' v. 389; liv. 106, 262; lvi. 295; lix. 250. 'Lancet,' July 21, 1827; Aug. 15, 1829; Oct. 31, 1829, vii. 254; Oct. 6, 1838; Nov. 3, 1838; and Nov. 24, 1838. 'Medical Gazette,' v. 411; ix. 895; xiv. 62; xv. 828; xix. 238; xx. 309. 'London Medical Review,' iv. 188; xix. 288. 'Guy's Hospital Reports,' No. iv. 68; and subsequent volumes. See, also, 'Lancet,' 1836, ii. p. 336, for an account of a series of cases, in which nervous symptoms were a marked feature.

weeks; at the end of three montl
twelve hours, or three or four tim
tinued, even after the lapse of two
attacks. In the case of Helen
debility of the limbs for three mon

Post-mortem Appearances.—Th
inflammation, spreading over the
the rugæ in well-defined patches, o
of the bright tint of inflammation
hue of congestion. When the poi
most common and characteristic a
more patches, from the size of a sh
sisting of a tough white or yello
mixed with coagulable lymph, firm
mucous membrane, and forming so
flammation. White spots of arsenic
between the rugæ. The annexed

Fig. 80.



tongue, fauces, and windpipe have been involved in the inflammatory action. The peritoneal covering of the stomach or of the entire abdomen is sometimes found in a state of inflammation, and the intestinal glands are swollen. Among occasional post-mortem appearances may be mentioned, inflammation of the bladder, livid spots on the skin, and congestion of the brain with serous effusion; but the most remarkable post-mortem appearance is the absence from the lining membrane of the stomach of all traces of inflammation, and of every other characteristic change. This anomaly is not due to death having taken place before inflammation could be set up; for well-marked inflammatory appearances have been present in the most rapidly-fatal cases.

Arsenic, like phosphorus, has been found, both by experiments on animals* and by clinical observation, to cause a fatty degeneration of the muscles and of various organs, especially the liver, the kidneys, and the glands of the stomach. A fact of more physiological than toxicological interest has likewise been pointed out by Saikowski—viz., that in animals poisoned by arsenic artificial diabetes cannot be caused by the usual method.

It happens fortunately for the ends of justice that arsenic not only preserves the stomach when surrounding parts are in a state of advanced decay, but that even the characteristic appearances of inflammation may be present after the body has been buried several months.

Fatal Dose.—In a solution, as small a quantity as *two grains* may prove fatal. *Two grains and a half*, contained in two ounces of fly-water, killed a strong healthy girl ætat. 19, in 36 hours (Letheby). Much smaller quantities have given rise to alarming symptoms. On the other hand, recovery has taken place from doses of half an ounce, an ounce, and even an ounce and a half, of the poison in substance. These larger doses are often taken on a full stomach, and are promptly rejected with the food, or carried away by the brisk action of the bowels.

Fatal Period.—The poison has proved fatal in *two hours*, in three or four instances (one by Mr. Foster, of Huntingdon, and one by Mr. Macaulay, of Leicester), but Mr. Thompson communicated to Dr. Taylor a case fatal with tetanic symptoms in *twenty minutes*. On the other hand, cases may prove fatal after three, four, five, six, or seven days, or even as late as the second or third week, and from secondary symptoms, in two or three years. The average duration of fatal cases is 20 hours, of those which terminate within 24 hours, less than 7 hours. As many as 85 in the 100 die within 24 hours. More than half the cases terminate

* Virchow's Archiv. xxxiv.

This statement is based on 92 cas
equally divided between men and

Commencement of Symptoms.—
after taking the poison; and they
in immediately. But they may b
one case ten hours). It is natura
delay the operation of the poison.

Treatment.—As arsenious acid
is sometimes, especially when sw
meal, completely rejected from th
the exhibition of an emetic, or the
contents of the stomach are dischar
When, on the other hand, it is ta
attaches itself to the mucous coat
and the formation of a tenacious s
surface, and protects it from the
antidotes. In the first class of cas
to some substance which is though
antidote. Arsenic, also, by its pur
free an evacuation of the bowels as
by this channel.

The first step in the treatment c
as promptly as possible from the st
is at hand it should be used without
itself is acting freely as an emetic,
by copious draughts of warm milk
throat with a feather. If the p

which happen to be most urgent. If the inflammatory symptoms run high, blood may be taken by leeches from the pit of the stomach. When coma threatens, blood may also be removed with advantage. The state of collapse must be met by stimulants, and the nervous symptoms by anodynes. Tetanic spasms would be best relieved by chloroform. The intense thirst may be satiated with small quantities of iced water; the tenesmus and dysuria by injections of gruel containing laudanum; the diarrhœa, if ineffectual and painful, by castor oil mixed with milk. Antimony must not be given as an emetic; for the resemblance of the crusts of antimony to those of arsenic would give rise to an objection to the chemical evidence. The sulphates of zinc and copper, and antidotes containing iron ought also to be avoided, lest it should be alleged that arsenic existed in them as an impurity.

Antidotes.—Several preparations of iron, of which the hydrated sesquioxide is the best, the hydrated oxide of magnesia, calcined magnesia, and animal charcoal, have been recommended as antidotes applicable to arsenious acid in solution. The hydrated sesquioxide of iron, formed by precipitating the tinctura ferri muriatis of the shops with excess of ammonia, renders a solution of arsenious acid wholly or nearly inert, and some experiments on dogs made by Dr. W. Watt prove that, as an antidote for arsenious acid in solution, it is really efficient.* It should be freely given in the moist state. The hydrated oxide of magnesia precipitated from a strong solution of the sulphate by liq. potassæ, and well washed, has been also shown to be effectual, and is free from objection should the patient die, and an analysis of the contents of the stomach be required.† When the poison is given in the solid form these antidotes are much less efficacious; and still less so when it adheres to the lining membrane.

While treating a case of poisoning by arsenious acid, or by other preparations of arsenic, it should be borne in mind that evidence of poisoning may be obtained by examining the urine, the serum from a blistered surface, or the blood, as well as from the matters vomited or passed from the bowels.

Arsenious acid has been introduced into the body otherwise than by the mouth. It has been inserted into the vagina, producing intense local inflammation, and the characteristic general symptoms of arsenical poisoning. It has been applied to the skin in the form of a mixed powder and of ointment, with similar local

* Wormley's 'Micro-Chemistry of Poisons,' p. 247.

† See a paper by Chevallier ('Ann. d. Hygièn.' xxx) on the Efficacy of Iron and Magnesia in Poisoning by Arsenic. The iron seems to have proved most effectual.

Arsenite of Potash.—The activ
in which it may be readily detec
scribed for arsenious acid.

Arsenic Acid.—This acid, thou
medico-legal interest except as
for detecting arsenious acid. It i
completely volatilized by heat, ve
a strong acid reaction. It yields
duced with charcoal, and a metallic
or Reinsch's method; and gives
phuretted hydrogen, on boiling.
by nitrate of silver, and by the am

The salts of arsenic acid (arsenat

Arsenite of Copper (Scheele's
powder, containing one part of ar
copper. It yields distinct crystals
and a residue of oxide of copper; i
and in nitric acid.

Aceto-Arsenite of Copper.—Th
known as mineral, Schweinfurt, Em
in England as emerald green, or
by paper-stainers, for fancy and
impart a full green colour, and mix
powder, or whiting, to give more de
used to give a green colour to
wafers, toys and cages, cakes of wa
of dress, and papers used as wrappe

Tests.—The powder

is dropped into it, a precipitate of the yellow arsenite of silver will be formed. If a paper stained with emerald green be touched with liq. ammoniæ, the spot and the liquid turn blue.

Symptoms.—Those of the acute form of poisoning may be inferred from the case of a print-colourer admitted into King's College Hospital, June, 1858. Death was caused by an ounce of the poison in seven hours, under symptoms belonging to the second variety of arsenical poisoning described at p. 469. He did not vomit till an emetic was given, and diarrhœa did not form a prominent symptom. He was pale, excited, faint, and anxious, with a small feeble pulse, slight epigastric tenderness, intense thirst, profuse cold sweats, severe cramps in the calves of the legs, and in the hands, with twitchings of the legs and arms. He never rallied, and died exhausted. The tongue was tinged green, and the matters rejected from the stomach and bowels were of the same colour. The stomach-pump was used, and the hydrated sesquioxide of iron freely given. The post-mortem appearances were a dirty green tongue; in the stomach a large quantity of the antidote speckled with green; congestion of its mucous coat, and of that of the small intestines; deep chocolate colour of the folds of the stomach, and dots of extravasated blood over the surface, especially near the pylorus. Lungs greatly congested; brain and kidneys sound.

It may be stated generally that the symptoms, post-mortem appearances, and treatment of poisoning by the arsenite of copper and by the aceto-arsenite, are those of poisoning by arsenious acid. In two cases the symptom of jaundice showed itself as if the copper had proved active.

Very severe, and even fatal, symptoms of irritant poisoning have been induced by eating substances coloured with arsenite of copper.

The symptoms of the chronic form of poisoning by inhaling and swallowing the powder detached from the walls of rooms have not been uniform. They have consisted of several of the following symptoms variously grouped:—The sneezing and lachrymation of a common cold; cough; nausea and loss of appetite, sickness and diarrhœa, colic pains, cramps, and spasms, dryness of the tongue and throat, and thirst; depression and weakness, headache, drowsiness, and extreme weakness, or actual palsy of the extremities. (In one case the dropped hand, as in poisoning by lead, in another great weakness and unsteadiness of all the limbs.)

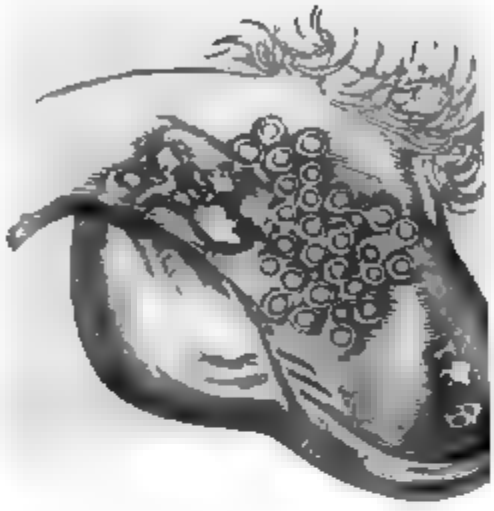
When the powder is largely diffused through the air, as in chromo-printing, the consequences may show themselves in a quarter of an hour, or even less; and they commonly appear in

pudenda; thirst, nausea, anorex
vomiting, colic pains and cramp
breath; great weakness, fever, hea
ness, restlessness, tremblings, and

One fatal case, at least, has occ
lowing this occupation. In the
inquiries made me acquainted, th
on for eighteen months, and she
occurred every five minutes for sev

Arsenite of copper mixed with

Fig. 91.



below. I have seen the circular ulcers more than once. The ulcerations of the fingers are well shown in fig. 92, after an illustration by Vernois. The green powder is found adhering to their edges. Dr. Prosper de Pietra Santa, in the 'Annales d'Hygiène,' October, 1858, p. 339, gives a similar account of the effects of Schweinfurt green as used in Paris. See also an able paper by M. A. Chevallier in the same journal, July, 1859; a paper by Dr. Vernois in the 'Annales d'Hygiène,' year 1839, p. 346; and Dr. Guy's report on 'Alleged Fatal Cases of Poisoning by Emerald Green, &c.,' in the 'Fifth Report of the Medical Officer of the Privy Council,' 1862. See also an interesting paper on poisoning from wall-papers, by Dr. Kirchgässer, in the 'Vierteljahrschrift f. Gericht. Med.,' ix. p. 96, of which there is also a full abstract in the Biennial Retrospect of the Sydenham Society' for 1867–68.

Fig. 92.

Cases of poisoning have occurred in aniline dye manufactories, and local eczematous affections have been observed as resulting from the wearing of under-clothing dyed with these materials.

Arsenic is largely used in the preparation of the aniline colours, and these often contain a large proportion of arsenic acid as an impurity. (*See* 'Pharm. Journ.,' 1868, Oct.; 'Brit. Med. Journ.,' 1868, Oct.)

Arsenate and Binarsenate of Potash.—These are active poisons little used in this country. The arsenate is white, deliquescent, and very soluble, with the reactions of "arsenic acid." The binarsenate is known as "Macquer's neutral arsenical salt."

The Arsenate of Soda is used as a medicine in France. A grain of the salt to an ounce of water constitutes "Pearson's solution;" and paper soaked in a solution of one part of arsenate of soda and two of sugar and twenty of water, is in use for poisoning flies. The "*papier moure*" owes its poisonous properties to arsenate of potash.

Sulphides of Arsenic.—Realgar, or red arsenic, and orpiment,

liquids containing arsenious or arse
It is also occasionally taken as a p
adhering to the coats of the stom
formed, as already stated, by the
nascent sulphuretted hydrogen, t
In organic mixtures the sulphides
teristic colours. They are soluble i
from the ammoniacal solution by
with black flux and heated, they
p. 469); and when boiled with nitr
verted into arsenic and sulphuric ac

The symptoms of poisoning by
poisoning by arsenious acid; and
are also the same, with the excep
alimentary canal have a yellow c
membrane is tinged of the same h
poisoning by arsenious acid.

Arseniuretted Hydrogen.—Seven
gas, which is very rich in arsenic
little short of a grain of the metal), a
chemist Gehlen died on the ninth d
tion of arseniuretted hydrogen. It
generated, instead of hydrogen, by
arsenic. A very interesting series of c
and due to the inhalation of the ga
arsenite of copper, have been relat
symptoms were nausea, vomiting, thi
and foul tongue; a rapid pulse, ra

case resembles those rare instances of arsenical poisoning in which narcotic symptoms are very prominent. Such was the character of a case of poisoning by arsenic and laudanum which occurred some years since in King's College Hospital.

II. ANTIMONY AND ITS PREPARATIONS.

A few years since poisoning by antimony was so rare that the poison is not specified in the list of substances that proved fatal in the five years 1852–56. But since the trials of Palmer, Dove, McMullen, Hardman, Freeman, Smethurst, Winslow, and Pritchard, of which the three first took place in 1856 and the last two in 1865, the subject of poisoning by antimony, and especially by small repeated doses of tartar emetic, has assumed great importance.

The preparations of antimony which are important in a medico-legal point of view, are tartar-emetic and the chloride. The precipitated sulphide is of interest from being developed in testing for the poison.

The *metal* antimony shares with arsenic the property of combining with nascent hydrogen, and of being deposited in the metallic form on burning the jet of gas, or heating the glass tube through which it is passing. It differs from arsenic in not being volatilized, when in the mass, by the heat of the spirit-lamp, and with difficulty when in the form of thin films. In common with arsenic, mercury, and several other metals, it is deposited in the metallic form on copper when its solutions are treated after the method of Reinsch. The metal antimony often contains a minute fraction of arsenic.

The precipitated sulphide, formed by transmitting a stream of sulphuretted hydrogen through a solution of a salt of antimony, or by treating metallic stains of antimony with sulphide of ammonium, is of a characteristic orange-red colour, and like the black prepared sulphide yields metallic antimony when heated in a current of hydrogen gas.

TARTAR EMETIC (*Tartarized Antimony, Stibiated Tartar, Potassio-Tartrate of Antimony*).

This substance is found in the shops as a white powder, or as yellowish-white efflorescent crystals. In common with antimonial wine and James's powder, it may contain minute traces of arsenic, derived either from the metal antimony, or from the sulphuric acid used in its manufacture.

Properties.—Tartar emetic is soluble in about three parts of boiling and fifteen of cold water, but insoluble in alcohol; and it has a sickly metallic taste, and faint acid reaction.

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heated in the manner described
potate at 350°, to sublime sl
amorphous deposit on the gla
550°. c. When treated with a
of ammonium, the characteristic

2. *Is*,

a. A drop of a solution of tar
glass leaves a crystalline deposi
or microscope, is found to conta
either tetrahedra (1 and 2, fig.
edges removed (3), or some mod
all the crystals assume the one
in many cases both kinds are to
as in fig. 93; together with th

Fig. 93.

objection, but the three conjointly are conclusive. 2. A strong infusion of gall-nuts gives a dirty yellowish-white precipitate. 3. Ferrocyanide of potassium causes no precipitate.

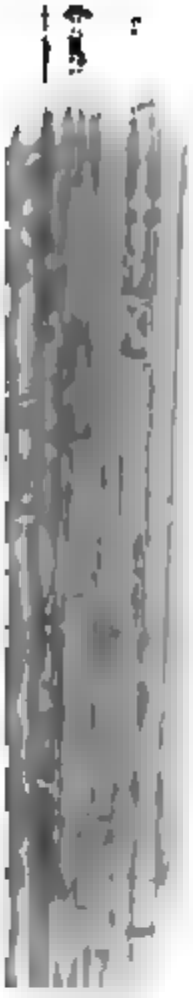
d. Introduce a portion of the solution into a Marsh's apparatus, and proceed as in the case of arsenic (p. 460). The crusts obtained by inflaming the jet generally possess a less distinct metallic lustre and a more smoky appearance than those of arsenic, but crusts may be obtained which might be mistaken for those of the latter metal. The crusts in the horizontal tube have a characteristic shape (fig. 87, p. 463) and tin-like lustre. For the mode of distinguishing the crusts of the two metals, see p. 462.

e. Treat the solution after the method of Reinsch (p. 464), taking care to use copper free from antimony as well as arsenic. The antimony deposit is generally of a violet tint, and does not yield a crystalline sublimate. It may be dissolved off from the copper, either, 1, by boiling the metal in a weak solution of permanganate of potash rendered slightly alkaline by liquor potassæ (Odling); or, 2, by a weak solution of potash and the frequent exposure of the metal to the air (Mr. Watson, of Boulton). If the first process is adopted, the solution of antimony must be freed from the brown deposit of the hydrated peroxide of manganese by filtration, slightly acidulated with hydrochloric acid, and treated with sulphuretted hydrogen gas. If the second process is adopted, the solution of the metal is filtered, acidulated with hydrochloric acid, and treated with sulphuretted hydrogen.

f. The metal may be separated from liquids containing it by the process of electrolysis described at p. 465. It is deposited on the platinum plate connected with the negative pole of the battery, and may be identified either by washing it with sulphide of ammonium, and evaporating the solution, or by either of the methods just described.

3. *In Organic Liquids.*

All vegetable substances containing tannin decompose the salts of antimony, and milk is coagulated by their strong solutions. Several other vegetable substances affect the action of the tests. Coloured fluids, though they modify the action of the other tests, have little effect on sulphuretted hydrogen, the sulphide retaining its characteristic colour. If no antidote has been given, and the poison has not been wholly rejected by vomiting, it may remain in the stomach unchanged. In this case we dilute, filter, acidulate with tartaric acid, transmit sulphuretted hydrogen gas, and obtain the characteristic orange sulphide of antimony. If this process fails, we adopt for the solid contents of the stomach



that of an ordinary medicinal d
poisoning; but when the quant
it has been administered as a p
was not given as a medicine.
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4. *Is t*

Antimony is absorbed, and
blood, and solid viscera of the b
the poison in the blood or solid
mended for arsenic (p. 466).
treated after the method of Re
(p. 460), or by electrolysis (p.
the metal must be identified i
by Marsh's method, by the char

Quantitative Analysis.—Use
fully washed and dried. One h
of crystallized tartar emetic.

Experiments

Large doses of tartar emetic,
given to dogs with impunity if t
few grains prove fatal when the
into the veins, it gives rise to vo
marks of acute inflammation in t
lungs. In some instances of sp
mation in any organ of the body

An interesting series of ex

days respectively, two after an interval of fourteen days, and one thirty-one days after taking the last dose.

The *symptoms* were *loss of appetite, loss of spirit*, and, after the sixth day, *great emaciation*. None of the rabbits *vomited*; and *diarrhœa* was absent in five out of eight. There were no *cramps*; but three of the five that died of the poison were violently *convulsed* a few minutes before death, and a fourth slightly so. Several of the animals had *ulceration of the mouth*, where the powder came in contact with the lining membrane. One of the rabbits, being with young, aborted.

The *post-mortem appearances* consisted in *congestion of the liver* in all the rabbits, *vivid redness* of some part of the lining membrane of the *stomach* in most, *ulceration* in two; and cartilaginous hardness of the pylorus in some. The *small intestines* in some of the animals presented patches of inflammation throughout, and, in two, the *solitary glands*, throughout the bowels, were enlarged, prominent, of a bright-yellow colour, and loaded with antimony. The colon and rectum were nearly always healthy. In two instances the mucus of the stomach or bowels had a brownish colour, attributed to the formation of the sulphide. The *kidneys* were generally more or less congested, and the bladder vascular, and distended with urine. This was not the case, however, in the animals that were killed after a few days, or some time after the discontinuance of the poison. The *brain*, *heart*, and *spleen* were always healthy, but the *lungs* in many cases were deeply congested, and in some acutely inflamed, sometimes hepatized, and gorged with blood, the air-tubes being of a bright-red colour. Bloody extravasations (or exsudations) were found in the cavities of the chest and abdomen, and also between the muscular and mucous coat of the cæcum, in more than one instance.

The poison was found, by means of Reinsch's test, in every part of the body—*always* in great abundance in the *liver*; in smaller quantity in the *spleen*; at the earliest period in the tissues of the *stomach*; at a later period in the *kidneys*, and in the *cæcum*. The fæces always contained the poison—in one rabbit killed fourteen days, in another twenty-one days after the last dose. Antimony was also found in the *lungs* from an early period. In the *muscles* and in the *blood* it was difficult to detect; but it was found in the *bones* on the fifteenth day, and thirty-one days after the poison had been discontinued. It was also found in the fœtal rabbits, of which one of the poisoned animals aborted.

The poison was being constantly eliminated by the kidneys. It was discoverable in the urine after the twelfth dose: and in that voided twenty-one days after the poison had been suspended. This

and also the length of time requir
cases; that there is a considerable
toms and morbid appearances prod
uniformity; that the poison perm
the body, and even those of the unl
tion is continued long enough, whi
stantly being eliminated from th
bowels; and lastly, that the fatal e
to the apparent changes found afte

These conclusions are generally i
the experiments of Messrs. Millo
('Annales d'Hygiène,' vol. xxxvi. p

SYMPTOMS, POST-MORTEM APPE

Symptoms.—The symptoms of
subject are:—A strong metallic t
swallowing, with heat, constriction,
throat, followed by nausea, vomitin
epigastrium, extending to the whe
repeated and profuse diarrhœa, w
tremities, and symptoms of collapse
a small quick pulse, and great weal
this state of collapse; but it is not
convulsions, and tetanic spasms. L
insensibility as one of their earlies
instance the characteristic pustular
skin and in the throat. In some ex
no vomiting and no purging till othe

occurrence of very dangerous symptoms.* Very severe effects have been produced by so small a dose as six grains. It has often been given in inflammation of the lungs, in doses of two grains, repeated at short intervals, without producing any injurious effects.

Fatal Period.—Tartar emetic, in a single large dose, may kill in a few hours (in an adult female, quantity unknown, in 7 hours —Wormley); but, on the other hand, a patient survived nearly five days the taking of forty grains, and a scruple of the poison proved fatal to a woman after a year of suffering.

Mortality.—Somewhat less than half the cases.

Tartar emetic applied externally in lotion or ointment causes inflammation of the skin and a crop of pustules, and, if continued, may produce sloughing. Nausea and vomiting have sometimes attended this external use of the poison.

Post-mortem Appearances.—Inflammation of the mucous membrane of the stomach extending sometimes to the small intestines; rarely to the throat and gullet. Sometimes inflammation in the lungs, and in the brain. After death by repeated small doses, special attention should be paid to the state of the cæcum and large intestines.†

Treatment.—The best antidote is tincture of cinchona bark. When this is not at hand, the decoction or powder may be substituted, or liquids containing tannin, such as strong tea, or decoction of oak bark. In the absence of the antidote, or while it is being prepared, vomiting should be promoted by warm water, milk, or mucilaginous drinks, and by tickling the throat with a feather; or the stomach pump may be employed. The after-treatment must be determined by the symptoms. Opium may be prescribed with advantage.

Chronic Poisoning.—The experiments of Dr. Nevins already detailed have removed any doubt which may have attached to recent medico-legal cases, as to the power of tartar emetic, in repeated small doses, to destroy life. It gives rise to nausea, vomiting, and purging, extreme debility, and fatal exhaustion; and the like symptoms have occurred in man.‡ In infants and

* See a case by Dr. Gleaves: Wormley's 'Micro-Chemistry of Poisons,' p. 217.

† See *ante* for the appearances in animals; and for the appearances in the human body in one case where antimony was found, and believed to have been repeatedly administered, see 'Observations on the Medical Evidence in the Case of The Queen v. Smethurst.' By T. G. Geoghegan, M.D., 'Dublin Med. Press,' 1859. Saikowski has observed similar fatty degeneration of the tissues and organs, to that which occurs after poisoning with phosphorus or arsenic.

‡ See Dr. Geoghegan's paper just quoted; and for a full report of the

Chloride of Antimony

A corrosive liquid, of a light- has been taken by mistake for wine. When largely diluted wit antimony falls down, and the c muriatic acid by the addition of of a white precipitate on adding solutions of the salts of bismuth: bismuth yields a black, and antin

Symptoms.—The action of th violent. In one fatal case, death half after swallowing between tw Narcotic symptoms were added the alimentary canal, and after d the entire canal presented a charr and abraded. Recovery has tak ounce of the poison.

Treatment.—That of poisonin draughts of warm water should l lowed by tincture of bark.

III. MERCURY AND I

These are in common use in the are occasionally used as poisons. among the ascertained causes of after oxalic acid, and they are cre

nine suicidal. Metallic mercury, as used in the arts, gives rise to severe and well-defined maladies, and the medicinal preparations of mercury occasionally prove fatal when given in an overdose, or in an ordinary dose to persons very susceptible to their action. The metal itself is inert, and may be given in large quantities without injury; but its oxide when diffused through the air, or brought into constant contact with the skin, is well known to produce injurious effects.

One important property of metallic mercury requires to be noticed, as it is made use of in medico-legal inquiries. It sublimes unchanged at 660°, and when the sublimation is conducted in a glass tube, a ring of small metallic globules is deposited. When more minutely divided, it has the appearance of a black powder; in which form it is thrown down from solutions of its salts.

The most important preparations of mercury are :—the chloride or corrosive sublimate; the sub-chloride, or calomel; the ammonio-chloride, or white precipitate; the red oxide, nitric oxide, or red precipitate; the sulphide, cinnabar, or vermilion; the subsulphate of the oxide, or Turpeth mineral; the bicyanide, or prussiate; and the two nitrates. The black sub-oxide, and subsulphide are less important.

Of these, corrosive sublimate is by far the most important.

CORROSIVE SUBLIMATE (*Oxymuriate, Corrosive Muriate, Bichloride,* more properly *Chloride, of Mercury*).

This substance is used for preserving the feathers of birds and skins of animals from moth; for destroying bugs and killing lice and maggots in man and in animals; and when dissolved in spirits of sweet nitre as a popular remedy for gonorrhœa and syphilis.

Properties.—A very heavy crystalline mass, or white powder, of a peculiarly nauseous taste, permanent in air, but slowly decomposed in sunshine, an insoluble grey powder being formed. It is soluble in twenty parts of cold, and two of boiling, water; and more soluble in alcohol and ether, for which reason ether is used to remove it from its aqueous solutions. Common salt, also, increases its solubility.

Tests.—We may encounter the poison in *substance*, in *solution*, in *organic liquids*, and in the *tissues and organs of the body*.

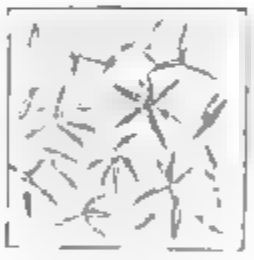
1. *In Substance.*

When heated on platinum foil it is wholly dissipated in white

acrid fumes. Heated on a porcelain slab with the flame of a spirit-lamp, it sublimes at 200° Fahr., and melts at a higher temperature. The sublimate received on a superimposed disk of glass consists of small groups of plates mostly drawn to a point at one or both ends, and often radiating two, three, or more from a point. Fig. 94 shows a coarse, and fig. 95 a more delicate specimen, the last from a photograph. The arrangement shown in fig. 96 is less common in sublimates than in deposits from liquids. If a sublimate does not happen to be characteristic, a minute drop of liquor potassæ applied to one part of it, and of solution of iodide of potassium to another, will identify it by the yellow and scarlet reactions. These tests are conclusive. The great solubility of corrosive sublimate in water further distinguishes it from arsenious acid and calomel.

Fig. 94.

Fig. 95.



× 60.

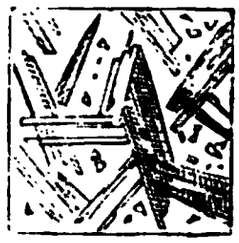
The addition of a few drops of liquor potassæ places the nature of the substance beyond a doubt. It turns yellow, while arsenic undergoes no change, and calomel is blackened. We may obtain still further assurance by the following tests: 1. Sulphide of ammonium blackens the powder. 2. A solution of iodide of potassium turns it to a bright scarlet. 3. Moisten a clean rag with dilute hydrochloric acid, sprinkle the powder upon it, and rub it on a clean plate of copper: it produces a silvery stain readily volatilized by heat. 4. Mix one part of the poison with four parts of calcined bicarbonate of soda; place the mixture in a dry reduction-tube (fig. 47, p. 404), or in the short tube (fig. 48, p. 404), and cautiously apply the heat of a spirit-lamp; a ring of globules will be formed on the cool sides of the tube, or on the glass disk placed over its mouth.

2. *In Solution.*

a. On the supposition that we are ignorant of the contents of a liquid submitted to analysis, we may ascertain that it contains

a crystalline salt by evaporating a drop of it on a glass slide, and examining the dry spot under the microscope. Corrosive sublimate is deposited, in long single needles, plates branched or stellate, as in figures 94, 95, or in parallel groups of needles or plates, as in fig. 96. *b*. Or we test for a base by sulphuretted hydrogen, which yields with corrosive sublimate a black precipitate, first giving a milky appearance to the liquid. *c*. Sulphide of ammonium also gives a black precipitate. *d*. With liquor ammoniæ it yields, in common with lead and bismuth, a white precipitate, but with liquor potassæ a yellow (the hydrated oxide). By this we recognise a per-salt of mercury. The supernatant liquor contains chloride of potassium, and if we add to it nitrate of silver we obtain the white chloride, which proves that the salt of mercury is a chloride. *e*. This yellow precipitate being collected, washed, and dried, and heated in a reduction-tube, gives a well-defined ring of mercury. The sulphide precipitated by sulphuretted hydrogen, or by sulphide of ammonium, when dried and heated with bicarbonate of soda, also yields a ring of mercury.

Fig. 96.



Additional tests: 1. Protochloride of tin. A solution of this substance throws down a white precipitate, turning rapidly to grey, and from grey to black. The black deposit is minutely divided mercury. The supernatant liquor being decanted or separated by filtration, and the deposit dried, the globules coalesce. 2. Metallic test. Acidulate the liquid with a few drops of hydrochloric acid, and introduce a narrow slip of clean copper. A grey film will be formed on its surface. This being carefully dried, placed in a reduction-tube, and heated by the spirit-lamp, yields a ring of metallic globules. Pure tin, zinc, or silver may be substituted for copper; but the latter is to be preferred. 3. Galvanic test. Take a narrow strip of zinc foil, and coat it with gold leaf; drop this into the solution slightly acidulated with hydrochloric acid; the gold will soon be covered with a grey film. Remove it from the solution, dry it carefully, introduce it into a reduction-tube, and heat it. A ring of metallic globules will be formed. This test is applicable to very minute quantities. The metallic deposit may be readily obtained by placing a drop of the acidulated solution on a surface of clean copper or gold, and touching the moistened metal with a fragment of zinc or iron. Wollaston once showed this reaction, in court, with a key and a sovereign.

Mercury is one of the metals deposited on copper when its solutions are treated after the manner of Reinsch (p. 464). The

copper, dried and heated in a reduction-tube, yields a ring of metallic mercury.

The acid in combination may be shown to be the hydrochloric by testing the fluid from which the mercury has, by any of the foregoing methods, been precipitated, with nitrate of silver, which yields a white precipitate of chloride of silver.

3. *In Organic Liquids.*

Corrosive sublimate is sometimes swallowed in substance, or imperfectly dissolved; and though very soluble, may be found in the stomach in a solid form, and may be separated by diluting the viscid contents with distilled water, stirring them, allowing the heavy corrosive sublimate to subside, and quickly pouring off the supernatant liquor. More commonly the poison is given dissolved in water or in some liquid suited to disguise its taste; and, when so given, may be decomposed by the contents of the stomach, or by the mucous membrane itself. The poison may, therefore, exist in the stomach partly in solution undecomposed, partly in combination with its contents, partly in union with its coats.

If any of the poison exists in the free state, it may be readily separated by diluting the contents of the stomach with distilled water, obtaining a clear liquid by filtration, shaking it in a stoppered bottle with an equal bulk of ether, and drawing off the ethereal solution with the pipette. By evaporating a drop of the solution on a glass slide, the crystals depicted in fig. 96 will remain, and may be tested by minute drops of the reagents.

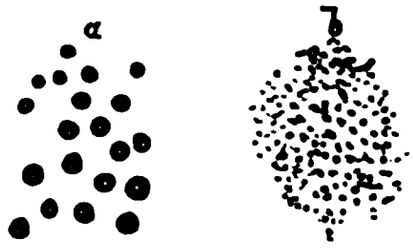
The solid contents of the stomach may be examined by the same method as for the organic tissues.

4. *In the Organic Tissues.*

Bring the organic matters into a state to pass the filter by the method described at p. 396; and test the liquid by the method of Reinsch (p. 464). If the copper receives a grey coating, wash it in distilled water, dry it, and heat it in a reduction-tube (fig. 47, p. 404). Globules of metallic mercury will be deposited on the cool side of the tube, or on the glass disk (fig. 48, p. 404). When, as in examining the tissues, we have to deal with small quantities of mercury, we should employ the form of reduction-tube figured at p. 405. This test is a very delicate one. The five-thousandth of a grain can be readily sublimed and identified. The appearance of a group of globules obtained from this small quantity of the metal is shown in *a*, fig. 97, where they are magnified 70 diameters and measure $\frac{1}{100}$ inch. Sometimes the metal is oxidised,

and then presents the appearances depicted in *b*, fig. 97. Among spots of no very defined shape are found a number of prismatic crystals, some scarcely longer than their breadth, while others are long needles.

Fig. 97.



As arsenic deposited on copper by Reinsch's process, and sublimed in the same way, may also yield distinct globules (fig. 76, p. 451), having a strong metallic lustre, it will be necessary to distinguish the one from the other.

The distinction is rendered easy by the fact that the globules of arsenic obtained in this way are always mixed with the characteristic octahedral crystals of arsenious acid, while those of mercury are either unmixed, or blended with the small needles just described and figured.

When a liquid found in the stomach, or obtained by simple boiling, yields mercury by any of the processes now described, we have evidence of a soluble salt of mercury, and a strong presumption in favour of corrosive sublimate; but when the solid matters after evaporation to dryness are treated with hydrochloric acid, we have no evidence of a soluble salt, because even an insoluble salt, thus treated, would be converted into corrosive sublimate. This process, then, is open to the objection that the mercury which it is the means of discovering may have been administered as a medicine in the form of calomel, blue pill, or grey powder. This objection could only be answered by distinct evidence of such substances not having been given as medicine, or by the characteristic symptoms and post-mortem appearances due to corrosive sublimate being present.

Corrosive sublimate, like arsenic and other active poisons, may be rejected from the stomach so as not to be detected after death.

Quantitative Analysis.—The quantity of the poison is best determined by means of the protochloride of tin. The protochloride should be added to the liquid containing the poison so long as any precipitate falls, which should then be washed, dried, and weighed. Of the metallic mercury thus thrown down 100 grains correspond to 135½ of corrosive sublimate.

When there is reason to believe that the quantity of the poison is considerable, we may follow with advantage the summary process recommended by Christison. The solid matters are to be triturated with protochloride of tin, when the mixture will assume a slate-grey colour, and separate readily into a liquid and coagulum. The liquid may be rejected, but the coagulum, having been

washed on a filter, must be carefully removed and boiled in a moderately strong solution of caustic potash until all the lumps disappear. The oxide of tin with the animal and vegetable matters are thus dissolved, and the solution, on remaining at rest, deposits a heavy grey powder, consisting chiefly of finely divided mercury. To separate the mercury completely, the solution must be allowed to remain at rest, at a temperature little short of boiling, for about twenty minutes. The supernatant liquor may then be drawn off, and the remaining black powder, after repeated washings, may be removed, heated, and sublimed.

Experiments on Animals.

The experiments of Sir Benjamin Brodie show that corrosive sublimate is a very active poison. Six grains dissolved in six drachms of water killed a rabbit in 4½ minutes, and a scruple proved fatal to a cat in 25 minutes. The rabbit became insensible in three minutes, and was convulsed; and on opening the chest the heart had ceased to beat, and its left cavities contained scarlet blood. The mucous membrane at the cardiac end of the stomach was of a dark grey colour, much softened and readily detached; but similar effects were produced by the poison after death. Sir B. Brodie attributed its fatal effects to this chemical action. Dr. Bostock and other experimenters, by giving smaller doses, produced the common symptoms of irritant poisoning, followed by death after some hours; and on dissection the mucous membrane of the stomach was found inflamed.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Immediately, or within one or two minutes of swallowing a substance or liquid of a peculiarly nauseous, metallic, styptic taste, there is a sense of tightness and burning in the throat and gullet, greatly increased by pressure, and by attempts to swallow, speedily followed by burning pain in the epigastrium, also increased by pressure. Vomiting and purging of stringy mucus or of bilious matter often containing blood ensue, and the entire abdomen becomes distended and exquisitely painful. The face is generally flushed and swollen and the eyes sparkling; but in other cases the countenance is pale and anxious, the lips white and shrivelled, and the eyes dull but expressive of great anxiety. The diarrhœa is accompanied with tenesmus, and dysuria is often present, the secretion of urine being scanty or altogether suppressed. The pulse is full, quick, and frequent, or small, frequent, and intermittent, according as the symptoms are those of high

fever or of collapse; and the breathing is quick and catching. In some cases there are drowsy intervals of comparative ease, and this drowsiness sometimes deepens into coma. Nervous symptoms, consisting of cramps, twitchings, and convulsions of the limbs, are often present from an early period; and occasionally there is paralysis. Death takes place during a faint, in the midst of strong convulsions, or during protracted insensibility. To these symptoms, in most cases which do not prove rapidly fatal, salivation is superadded, and the painful train of nervous symptoms caused by the specific effect of mercury on the system.

But the symptoms are by no means uniform, nor is the mode of death always the same. Three varieties of cases at least may be recognised:—1. Violent irritation of the stomach and bowels, with collapse. 2. Salivation and other remote effects, with little or no irritation of the alimentary canal. 3. Irritation of the stomach and bowels, followed by salivation and remote constitutional effects.

Constitutional Effects of Mercury.—1. The most characteristic among the constitutional effects of mercury is *mercurial salivation*, characterized by a brassy taste, a peculiar fœtor of the breath, tenderness and swelling of the mouth, inflammation, swelling, and ulceration of the gums, an increased flow of saliva, a quick pulse, together with hot skin and other symptoms of fever. In the worst cases the salivation is profuse; the face, neck, and tongue swollen; the inside of the mouth ulcerated or gangrenous.

Several interesting questions arise out of this symptom of mercurial poisoning:—*a.* What is the smallest dose that will occasion salivation? *b.* Can salivation be produced by other causes, and if so, can we distinguish it from the effects of mercury? *c.* What is the earliest period at which salivation may occur? *d.* How long may it last? *e.* Can salivation cease and recur without a renewed use of the mercurial preparation? *f.* Is it possible to distinguish gangrene of the mouth, the effect of mercury, from the same disease due to other causes?

a. Smallest dose. There is much difference between individuals, between persons of different ages, and even in the same person at different times, in respect of the quantity of mercury which can be borne. As a general rule, children are less susceptible of the action of mercury than adults, the robust than the delicate. The same female who in her ordinary state of health is affected with difficulty, shall, when suffering from anæmia, be salivated with a few doses of blue pill. In scrofula and Bright's disease, and in affections of the nervous system, very marked

effects are often produced by small doses of mercury.* Again, there are many persons peculiarly susceptible of its action, and others whom the largest doses continued for a long time will not affect. Many instances of severe, and even fatal, effects produced by small doses are on record. In an apoplectic patient of Dr. Bright's five grains of calomel placed on the tongue produced in three hours violent salivation, and such swelling of the tongue as to render scarifications necessary. Three grains of corrosive sublimate in three doses have caused violent ptyalism; three five-grain doses of blue pill, given one every night, have proved fatal; two grains of calomel have caused ulceration of the throat, exfoliation of the jaw, and death; and the external application of three drachms of mercurial ointment has destroyed life in eight days. (Christison.)

b. Salivation from other causes. Salivation may occur spontaneously, so as to constitute a disease in itself, or it may be due to the mere accumulation of saliva, through some disease of the throat, such as quinsey, preventing deglutition. It may even be occasioned by the influence of the imagination, as in a case related by Christison. Various preparations of gold, copper, lead, arsenic, antimony, and bismuth; sulphuric acid, iodine, and iodide of potassium; several vegetable substances, such as castor-oil, foxglove, opium, and prussic acid, have also given rise to salivation.

The distinction between mercurial salivation and that dependent upon other causes is generally easy, in the first stage. Mercurial salivation is preceded by a coppery taste and peculiar fœtor of the breath, and accompanied by redness, sponginess, and ulceration of the gums. These are wanting in spontaneous salivation, and in that produced by most of the medicines just mentioned.† But the advanced stage of mercurial salivation seems to differ less strikingly from some severe affections of the mouth due to other causes, and accompanied by ptyalism. Thus in a curious account of an epidemic salivation, forming part of a tertian fever, quoted from Haller's 'Collections' on the authority of Quelmelz, it is stated that in one instance it was as great as

* In a case of paralysis of the facial nerve which came under my notice, there was a distinct red line upon the gums of the paralysed side, while the other was quite free. The sensibility of the affected side was perfect, though the patient complained of tingling. (G.)

† A case under my care when a former edition of this work was in the press seems to justify the cautious statement in the text. All the symptoms of severe mercurial salivation were present as the effect of a course of iodide of potassium, in the ascertained absence of mercurial preparations, other than those given from time to time as aperients, such aperients not having previously affected the system. (G.)

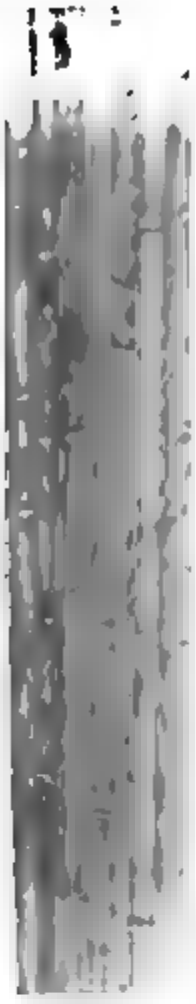
the most violent mercurial salivation, and was accompanied by fœtor, superficial ulceration of the mouth, pustules on the tongue, relaxation of the gums, and looseness of the teeth. (Christison.)

c. Earliest period. Mercurial salivation rarely sets in under twenty-four hours; but in Dr. Bright's case already cited, it appeared in three hours. In a case of poisoning by two drachms of corrosive sublimate, it began in four hours. (Taylor.) The shortest period, therefore, may probably be stated at three hours. It would seem that where salivation occurs very rapidly, the effect is rather due to reflex excitation of the salivary gland from local action of the poison on the mouth than to any specific action of the absorbed mercury.

d. Duration. This is very variable, and may be very considerable. It may continue from any period from a few days to as many years. In one instance it is alleged to have lasted six years. ('Lancet,' No. 453.)

e. Intermittent salivation. Dr. Robert Williams ('Elements of Medicine,' vol. ii. p. 523) gives a case on the authority of Dr. Daniel, in which salivation was suspended for eight or nine days under an attack of remittent fever, and then returned, though no mercury had been given after the fever came on. Instances of recurrence of salivation after three and even four months are on record; but in one case at least, quoted by Christison, the recurrent salivation was unattended by fœtor, redness, ulceration, or sponginess of the gums. The possibility of recurrent mercurial salivation is also confirmed by analogy; for in the case referred to in the foot-note to page 496, the salivation is proved to have taken place after the iodide of potassium had been suspended for several weeks.

f. Gangrene of the mouth. Cases of *cancrum oris* following exhausting maladies, or occurring in children badly lodged and badly fed, are not of very rare occurrence. In such cases it very seldom happens that mercury in some form has not been given. Hence a difficult question as to the cause of the disease. In the absence of any exact means of discrimination, it may be sufficient to state that extreme debility, brought on by any of the causes just mentioned, is a sufficient cause; and that even if the mercury which may have been given has contributed to the fatal result, the medical man is not to be blamed for the use of a medicine of great value in the diseases of children, and which less frequently causes salivation in them than in adults. It is generally stated that gangrene, the effect of mercury, may be distinguished by its beginning in the mucous membrane of the mouth and throat, while the cancrum oris begins in the skin of the



lique.—This disease occurs in n
the fumes of mercury, or causes
absorb it by the skin, such as q
mirror silverers, and baromete
suddenly, sometimes comes on g
be attended by salivation. The
first affected, and then, by degr
In the worst cases, the patient
walk. The unsteadiness of the s
any object, and the muscles of t
cannot plant his foot firmly on t
walk, his gait becomes an unste
paralytic affections occur, chiefly
like lead; but sometimes also
aphonia. Psychical symptoms
The patient becomes irritable a
demented or maniacal. If the p
he loses his memory, is unable to
dies. On leaving off his work h
recovery may occupy some wee
disease is incurable. The absor
indicated by a blue mark on the
more commonly by a dark red li
generally recognised, though ver
state of the teeth, causing them t
ment of this affection consists in
the swallowing of white of egg i
day may be recommended

arsenic. Corrosion, softening, and sloughing ulceration of the stomach and intestines are of frequent occurrence, and the peritoneum is often inflamed. The sloughs have been found to yield mercury on analysis. Sometimes the small intestines escape, and the poison acts only on the stomach and on the rectum, or on the large intestines generally. The decomposition of the salt by contact with the mucous membrane, with the contents of the stomach, or with antidotes, and the consequent deposition of minutely divided mercury on the lining membrane, as a thin slate-coloured covering, sometimes serves to identify the poison. When the body is in a state of decay, a similar appearance of the mucous membrane may be caused by the action of sulphuretted hydrogen, giving rise to the formation of the black sulphide. When mercurial salivation has existed during life, we find the mucous membrane of the mouth inflamed or sloughing.

One post-mortem appearance which has been more frequently encountered in poisoning with corrosive sublimate than in poisoning with arsenic, is the highly inflamed state of the urinary organs, and the contraction of the bladder, corresponding to the scanty secretion of urine during life.

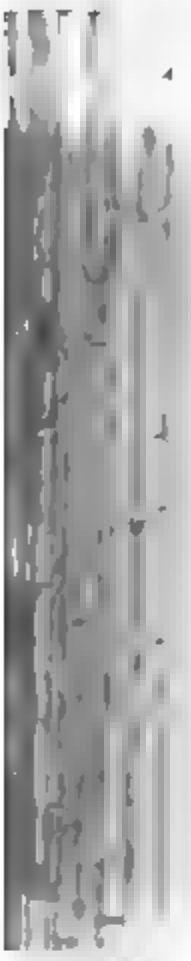
Intense inflammation and ulceration, and even sloughing of the cæcum and large intestines, is also a marked occurrence in poisoning by corrosive sublimate—more common than in poisoning by tartar emetic and arsenic. These appearances, in the case of a poison so liable to decomposition by the contents and tissues of the alimentary canal, are possibly due to the elimination of the poison by the glands of the large intestines.

Corrosive sublimate applied to the mucous membrane after death hardens it, and causes it to assume a dead white, wrinkled, and granulated appearance, with rose-coloured vessels ramifying upon it. These appearances extend to the muscular and peritoneal coats. Sir B. Brodie found the same effect to be produced on the living and dead mucous membrane.

Fatal Dose.—Three grains have proved fatal to a child. Very large doses have been swallowed with impunity, having been rejected by vomiting, or decomposed by the prompt use of antidotes.

Fatal Period.—The shortest period on record, *half an hour*, was in a case reported by Mr. Welch to Dr. Taylor. Cases of death in two or three hours are not rare. The nitrate of mercury has proved fatal in two hours and a half. In the case of corrosive sublimate, as in that of arsenic, the period is extremely variable.*

* The following periods are on record:—one of 2 hours; one of 2½ hours; one of 3 hours; one of 6 hours; one of 11 hours; and one of 3, 6, 8, and 11



acid, have also been suggested. are the white of egg and gluten given freely mixed with water, a present, accompanied, if necessar eggs cannot be procured, flour r be substituted. White of egg h antidote in so many cases, that w sary to resort to any other.

The rest of the treatment is t irritants generally. Where saliv drinks, and gentle aperients, wi salt, must be used. Acetate of medical treatment, would be obj Occasionally, when the inflammat general blood-letting may be re

Corrosive sublimate acts as an racteristic effects in whatever way system. Death has happened thr of corrosive sublimate.

CALOMEL (*Subchloride of Mercu*

Properties.—A heavy white c soluble in water, alcohol, and eth hydrochloric acids.

Tests.—On the supposition that of the powder, we first test it by l and arsenic, it volatilizes, but as a temperature of 240° Fahr. Its ins

Calomel, though generally a safe medicine, and one that may be given in many diseases in large doses often repeated, sometimes acts as a strong irritant poison, or destroys life by producing gangrene of the mouth and throat. Cases are on record of fatal results following a single dose of a scruple, fifteen, eight, and six grains. On the other hand, doses of three drachms, and of one ounce have been taken with impunity. In Asiatic cholera, and in the severe fevers of hot climates, calomel in repeated doses of one scruple has appeared to be beneficial.

These exceptional effects of calomel have been attributed to its partial conversion into corrosive sublimate by the free hydrochloric acid of the stomach, or by contact with chloride of sodium or muriate of ammonia. The quantity of corrosive sublimate formed by either of these reactions has been shown to be extremely small. A minute quantity of corrosive sublimate, such as the 500th of its weight, is sometimes found mixed with calomel.

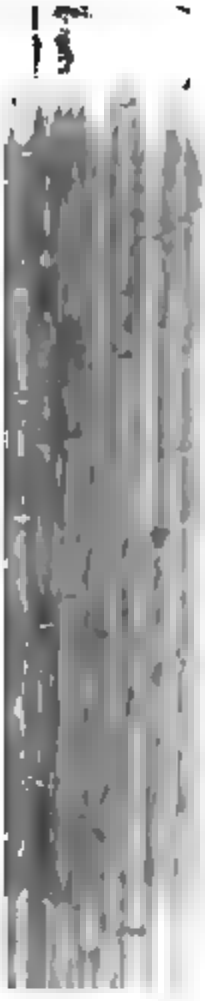
The other compounds and preparations of mercury possess poisonous properties; but as they are very rarely taken as poisons, a brief description of them will suffice.

Red Precipitate (red oxide of mercury).—This, mixed with lard or grease, is largely used for destroying vermin. Its crystals are small, brilliant, and of a scarlet or deep orange colour; the powder is orange-coloured. It is very heavy, insoluble in water, but soluble in warm hydrochloric acid, which converts it into corrosive sublimate. Heated in a reduction-tube it is entirely dissipated, metallic globules are sublimed, and oxygen gas given off.

Cinnabar, Vermilion (bisulphide of mercury).—Cinnabar is found in commerce as a dark red semi-crystalline mass, and Vermilion as a fine red powder. As thrown down from a solution of a per-salt of mercury by sulphuretted hydrogen, it is black; but, when sublimed, red. It is heavy, insoluble in water and muriatic acid, entirely dissipated by heat, but collects on the sides of the tube unchanged. When mixed with carbonate of soda, and heated in a reduction-tube, globules of mercury are sublimed; and on adding a mineral acid to the residue, sulphuretted hydrogen is given off, showing the presence of sulphur.

White Precipitate (ammonio-chloride of mercury).—A white heavy powder, insoluble in water, and entirely dissipated by heat. It yields with carbonate of soda a metallic sublimate. When boiled with liquor potassæ, ammonia is given off, and chloride of potassium formed, which may be detected by the nitrate of silver and bichloride of platinum tests: the yellow peroxide of mercury remains.

Turpeth Mineral (oxysulphate of mercury).—A heavy yellow



and yielding a highly acid and c
the crystals give off nitrous acid
Mixed with carbonate of soda ar
Liquor potassæ throws down a ye
in water, leaving dilute nitric aci
bonate of potash till effervescen
of potash. The subnitrate diffe
with liquor potassæ a *black* preci

Bicyanide of Mercury (prus
of white, heavy, inodorous crysta
taste, are soluble in hot and col
alcohol. When heated, the crys
cyanogen gas, recognised by the c
flame. When heated with hydr
given off. The solution yields w
sulphide of ammonium, a black
cipitate with liquor potassæ.

All the foregoing preparation
stances, been taken as poisons.
their solubility, the soluble nitra
small doses, being extremely acti
red precipitate, turpeth mineral,
powerfully. The soluble salts a
compounds as irritants; but both
mercury. The symptoms of the l
by a soluble salt of mercury; the c
to modify the action in any marke

IV. LEAD AND ITS PREPARATIONS.

Acute poisoning with the salts of lead is rare. One case only (by Goulard's extract) occurred in the two years 1837–8; and though no less than twenty-three deaths from the "salts of lead" are returned by the Registrar-General for the average of the five years 1852–56, it is obvious that they were chronic cases, for no case of lead poisoning occurs in the lists of suicides, murders, and manslaughters. From the great use made of lead in the arts, its effects as a slow poison are well known.

The metal itself is not poisonous; but as it is readily acted on by acids, it may impart poisonous properties to such liquids as wine, vinegar, and cyder, when used (as formerly in Devonshire) in making or repairing the cyder presses. When employed to line packing-cases for snuff and other commodities it may contaminate the contents. The metal may become poisonous by combining with the contents of the stomach.

The preparations of lead used in medicine or the arts, are the two oxides, the carbonate, the acetate and subacetate, the sulphate, the chloride, and the nitrate; of which the carbonate and acetate are the most important in a medico-legal point of view.

Tests.—On the supposition that we are ignorant of the base contained in a solution presented for analysis, we first transmit sulphuretted hydrogen through it, or add a few drops of the sulphide of ammonium. Lead is one of those bases which give with this reagent a black or deep brown precipitate; and liquor ammoniæ, liquor potassæ, and dilute sulphuric acid throw down a white precipitate. By this succession of trial tests, we infer that the solution contains a salt of lead.

The base is completely identified by the following tests: 1. Chromate of potash throws down a gamboge-yellow chromate of lead. 2. Iodide of potassium yields an iodide of lead of the same colour. 3. If a fragment of zinc the size of a pin's point be placed in a drop of the solution, the lead is deposited in one of the annexed forms.

Fig. 98.

The lead-tree is developed very rapidly, and should be examined under the microscope before it has become obscured by the white carbonate. This test acts characteristically on one grain of the acetate of lead in four ounces of distilled water.

Litharge (protoxide of lead
painters and glaziers. It form
kinds of earthenware; and ser
its being acted on by acids.
impart a sweet taste to sour win
hair-dyes in common use (p.
yellowish scales, volatile at a r
perfectly soluble, when pure, in a
the properties of nitrate of lead,
already described. It is readily
of the blow-pipe.

Minium, or Red Lead.—This
wafers; and is sometimes mixed w
insoluble in water, and is somet
acid. When heated, it gives off
orange-yellow protoxide. It is
pipe; and on burning the wafers
of lead form on the edges, mix
protoxide.

White Lead (cerusa, carbonate
in the arts, chiefly as the basis o
and thus becomes a common cause
forms of chronic poisoning by le
or as a heavy white powder, and
When heated to redness, it loses it
to the yellow protoxide. It is
with effervescence in nitric acid.

powder is also blackened by sulphide of ammonium, and changed to a fine yellow by iodide of potassium and chromate of potash. In solution, it gives the characteristic reactions of all the soluble salts of lead.

Goulard's Extract (subacetate of lead).—This is a yellowish-white alkaline solution, distinguished from a solution of the acetate by the copious precipitate of carbonate of lead, formed by transmitting a stream of carbonic acid gas through it. It is an active poison, and has more than once proved fatal.

Sulphate of Lead.—A heavy white powder, insoluble in water and in acids, unchanged by heat, and blackened by the sulphide of ammonium. Suspended in water, and exposed to the action of sulphuretted hydrogen gas, the black sulphide of lead is formed, the sulphuric acid remaining in the supernatant liquor, as shown by the nitrate of baryta test. This salt of lead, being extremely insoluble, is stated not to be poisonous; but if given in a very large dose might not prove quite inactive.

Chloride of Lead.—A white powder, sparingly soluble in cold, but more soluble in hot water, soluble in dilute nitric acid, but insoluble in alcohol. It has a sweetish taste. At a heat below redness, it fuses into a semi-transparent horny mass (*plumbum corneum*), but is volatilized by an intense heat. Its solutions have the reactions of a salt of lead.

A yellow oxychloride of lead is used as a pigment under the name of *mineral*, or *patent yellow*, and *Turner's yellow*. Like the chloride, it is fusible, and fixed when melted.

Nitrate of Lead.—This is a crystalline salt, soluble in water. It is largely used in calico-printing, and forms the basis of Ledoyen's disinfecting fluid. When heated in a glass-tube, nitrous acid vapour is given off, and the yellow protoxide remains behind. The solution gives the characteristic reactions of a salt of lead; and filtering paper dipped in it and dried, burns like touch paper.

Salts of Lead in Organic Liquids.—Add to the suspected liquid a little nitric acid; boil, filter, and transmit sulphuretted hydrogen gas. If a salt of lead be present, a black precipitate will be formed. If no precipitate falls from the liquid thus treated, collect the solid matters from the filter, incinerate, dissolve the ash in nitric acid, dilute, filter the resulting liquid, and transmit the sulphuretted hydrogen gas as before.

If by either or both of these processes a black precipitate is obtained, it may be proved to contain lead in two ways:—1. By placing the dried precipitate on a fragment of charcoal, and reducing the metal by the blowpipe. 2. By exposing the sulphide to a red heat in a tube of German glass open at both

also fragments and incinerated.

SYMPTOMS, POST-MORTEM AP

Symptoms.—All the salts of l
of the sulphate, act as weak irrit
irritants chiefly in the absence o
the opposite state—constipation.
rations act more feebly than m
not often prove fatal.

The usual symptoms caused by
lead are a burning and pricking
thirst; vomiting; colic pains wi
obstinate constipation; cramps,
convulsions, and tetanic spasms.
Diarrhœa is an exceptional occurr

The most important and interc
that which is brought on by th
rations of lead, as medicine, in th
accidental impregnation of water,

Chronic Lead Poisoning.—The
the same course; but generally th
for a time by disordered digestion
The gums often become swollen
the complexion cachectic. The p
the most characteristic phenomena
Colic, Painter's Colic, or *Coli*
Poictou, the district in France w
first observed. This affection is n

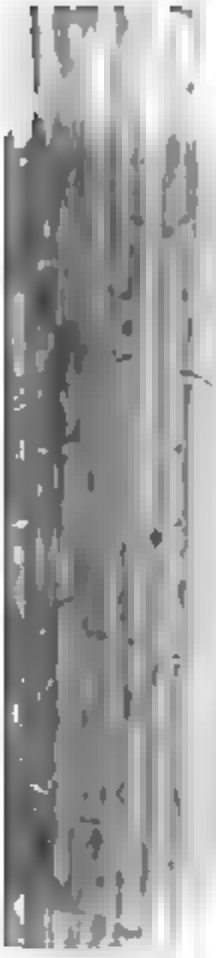
A very common sequence is the occurrence of neuralgic pains (saturnine arthralgia) affecting various parts of the body, such as the bones, the muscles, and skin. Sometimes there is anæsthesia. Another special feature of chronic lead poisoning is the occurrence of *Lead Palsy*. This is sometimes the termination of a single attack of colic, but more commonly it supervenes after repeated seizures. In some cases, again, it comes on without any previous attack of colic. The disease affects chiefly the extensor muscles of the forearm, so that when the arm is raised, the hand falls by its own weight. Hence the expression "dropped wrist." The paralysis is usually preceded by tremors in the affected muscles. It occasionally attacks the laryngeal muscles, and causes aphonia. The more advanced symptoms of chronic lead poisoning consist in affections of the brain and nervous system. Delirium is common, and affections of the mind either of a melancholic or maniacal nature. In other cases, epileptiform convulsions occur with or without loss of consciousness. The progress of lead poisoning is towards death unless the sufferer is withdrawn at an early period from the influences at work. A saturnine cachexia is developed, characterized by great prostration of strength, muscular atrophy, a dull earthy complexion, loss of appetite, and obstinate constipation, and death at length happens from cachectic dropsy, or from some intercurrent acute inflammatory attack. Disease of the kidneys, with albuminuria, is said to occur as the occasional result of lead poisoning; and gout is a frequent consequence of it.

The persons most subject to chronic lead poisoning are those employed at furnaces for smelting lead ore, manufacturers of litharge, and of red and white lead, house-painters, colour-makers, plumbers, and workers in lead, glass-blowers, glaziers, potters, and manufacturers of glazed cards. It occurs occasionally in persons who make comparatively little use of lead, as in compositors from the handling of the types, in fishmongers from the use of lead counters covered with brine.* In other cases, both in men and animals, it is traced to the use of drinking water contained in leaden pipes or cisterns, under the circumstances presently to be mentioned. In the several employments just mentioned, lead finds its way into the system either by the skin, the lungs, or the stomach.

The chief practical rule for the prevention of disease consists in the strict enforcement of cleanliness. A great amount of disease has been prevented by the substitution of moist for dry grinding.

A blue line on the gums at the margin of the teeth affords a valuable indication of lead poisoning. It is rarely absent where

* I have witnessed two or three cases among this class of tradesmen. (G.)



and duodenum, part of the jejun
verse colon were greatly inflam
stomach appeared as if macerat
ounces of a reddish-brown fluid
metallic taste, exhaled the odou
and yielded globules of lead wh
to the process of reduction. (Ch

In colica pictonum there are
beyond an unusual constriction o
palsy the affected muscles are fl
the disease has been of long c
fibrous tissue. Kussmaul and M
of long-continued poisoning by l
mucous membrane of the intes
muscular layers. Hypertrophy
degeneration of the nervous tis
ganglia of the sympathetic.

The mode in which lead acts h
vestigation, and is not as yet satis
to Henle the symptoms are prim
lead on the non-voluntary muscul
vessels, which are irritated to s
recent investigator (Heubel) is of
on the nervous system. The sp
muscles seen in "dropped wrist"
Lead is deposited in all the orga
brain yielding more than the musc

Treatment.—The antidotes to l

which may result from the action of the water upon it, it is important to examine the circumstances under which that action takes place. This subject has been carefully investigated by Drs. Christison, Taylor, and Miller. The principal results of their inquiries may be briefly stated as follows:—

The contact of air and water with the metal leads to the formation of an oxide which is dissolved in the water. The solution absorbs carbonic acid from the air, and the resulting oxycarbonate is deposited in silky scales. A fresh portion of oxide is formed and dissolved, and a fresh crop of crystals deposited; and in this way the metal is rapidly corroded. The free access of air is essential to these changes, for distilled water deprived of its gases by boiling, and excluded from the air, has no action on lead. The action of air and water on lead is very rapid when the water is pure. Thus distilled water, or very soft water, or rain water collected in the open country, left in contact with pure lead, with the free access of air, causes a very rapid corrosion of the metal; but the rain water collected from the roofs of houses in large towns, in consequence of the impurities which it dissolves, has little or no action on lead.

On the other hand, the action of water on lead is greatly modified by the presence of saline substances, even in the small quantity of three or four grains to the gallon. The chlorides and nitrates promote corrosion; but the sulphates, phosphates, and carbonates obviate it. Bicarbonate of lime is a very effectual preservative; and to its presence many springs owe their property of not acting on lead. Sulphate of lime, in so small a quantity as one part in 5000, also affords complete protection. Some kinds of river water, as that of the Thames, contain sufficient saline matter to render the use of lead perfectly safe. The same remark applies to most spring waters. But the waters of some rivers and springs are so destitute of saline matters as to act powerfully on lead. It must, however, never be forgotten that carbonic acid, if present in the water, will completely counteract the preservative effect of the salts above mentioned. It is better, therefore, to forego the use of lead for cisterns and water-pipes. Slate should be used for cisterns, and iron, earthenware, or glass for pipes.

It may be stated, then, as a general result, that the action of water on lead, and the consequent danger of conveying and preserving it in pipes or cisterns made of that material, varies directly as the purity of the water. It follows that we may render the use of lead for such purposes perfectly safe by the artificial admixture of saline matter with the purer kinds of water.

by a natural process of distillation,

There is another cause which gr water on lead, and may neutrali saline matter, and be even intensi the galvanic action excited by the metallic solder, with the lead.

Vegetable acids and fatty subst danger of keeping succescent fruits vessels made of the metal, or glass cider, wine, and rum have acquire way. Shot used for cleaning wine- them, have impregnated the wine

For the elimination of lead fro prescribe iodide of potassium in do times a day. Sulphate of magnesi bined with it.

V. COPPER AND ITS

Poisoning with the salts of copp 543 cases of poisoning in England was due to this cause, nor is the po General's list of the causes of vio 1852-56. In consequence of the m of copper, they are not likely to b are ill adapted to the purposes of t ever, occasionally taken by the unic ails in cookery sometimes leads to

common use in the arts. The hydrated peroxide, the carbonate, the sulphate, and the acetates, must be briefly noticed.

The Hydrated Peroxide.—This is met with as mineral green and as verditer. Mineral green formerly consisted of arsenite of copper, but is now formed by a combination of the hydrated peroxide with pure lime or chalk, potash, and alumina. Verditer consists of the same constituents in different proportion.

The anhydrous peroxide of copper is a brownish black powder which is readily dissolved by nitric acid, the solution assuming on the addition of ammonia in excess, a deep blue colour. The *hydrated* peroxide of copper may be procured by adding liquor potassæ to a solution of any of the soluble salts of the metal.

As none of the salts of copper assume the importance of arsenious acid or corrosive sublimate, it will suffice to consider the tests for copper generally, and then to describe and distinguish from each other those salts which are in common use.

Tests.—The salts of copper are distinguished from most other substances by being either blue or green. Sulphate of iron and the salts of nickel are also green, and will, therefore, have to be distinguished from the green salts of copper. In very dilute solutions the colour of the salts of copper disappears, or is so masked as to afford no clue to the nature of the substance with which we have to deal. On the supposition that we have no clue to the contents of the solution, we first test the liquid with sulphuretted hydrogen, which occasions a deep brown or black precipitate. Sulphide of ammonium yields the same precipitate. On adding liquor ammoniæ to the solution, the hydrated peroxide is first thrown down, but is redissolved on the addition of ammonia in excess, the resulting liquid having the characteristic deep blue colour of the hydrated peroxide.

The salts of copper in solution may be further identified by the following tests:—1. Ferrocyanide of potassium yields a fine hair-brown gelatinous precipitate; 2. Polished iron (a needle suspended by a thread) placed in the solution is soon coated with a thin film of the metal; 3. A drop of the solution placed on platinum foil, slightly acidulated, and touched with a strip of zinc, yields the same metallic deposit; 4. If a minute fragment of zinc is placed in a drop of a solution of a salt of copper on a flat surface of glass, the copper is deposited in an arborescent form; and distinguished by its colour.

Some of the salts of copper may have to be distinguished from each other.

Carbonate of Copper (natural verdigris).—This is the greenish coating formed on the surface of copper and its alloys by the

By adding a few drops of liquo
arsenious acid, green arsenite of
acid in combination is shown to
and nitrate of baryta test.

Subacetate of Copper (artificial
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combination of this with the a
Its colour accordingly varies, bei
green. The subacetate is known
heated in a test-tube by the flam
acetic acid is given off; and the
supplies carbon to deoxidise the c
is left on the side of the tube.
when the salt is boiled with dilute

Nitrate of Copper.—This consis
The acid in combination may be
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by the ruddy fumes of nitrous ac
crystals with tin filings in a few
adding liquor potassæ to the soluti
which may be identified by approp

Chloride of Copper.—There is
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An oxychloride is known as Brunsv

The tests for the base are the sa
The hydrochloric acid in combinati
of the soluble chloride, by the addi
insoluble subchloride must be conv

it a stream of sulphuretted hydrogen, the brownish-black sulphide is thrown down. This must be collected, washed, and dried; and incinerated in a glass tube, so as to free it from adherent organic matter. The sulphide may now be converted into sulphate by treating it with a few drops of nitric acid. The solution strikes the usual deep blue colour with an excess of ammonia.

If copper is not by this means detected in the liquid which has passed the filter, the insoluble substances which remain on the filter, or are contained in the stomach, must be dried and heated to redness in a crucible, till they are completely charred. The residue contains metallic copper, and must be gently heated in equal parts of nitric acid and water. Nitrate of copper is thus formed, which may be identified by the usual tests.

Copper has been detected in the solid organs of the body, but more rarely in the secretions, in cases of poisoning by its salts. But it has been asserted to be a normal constituent of the animal frame, and of several vegetable substances used as food. M. Boutigny has traced it to the manure used in raising those substances. Its presence as a natural constituent of the human body, has, however, been rendered doubtful by the negative results of experiments performed by Christison and Chevreul. As the quantity of copper existing naturally in animal and vegetable substances does not exceed in any case one part in 120,000, and is in some instances so little as one part in 1,500,000, it can give rise to no fallacy even where large portions of the solid contents of the stomach or of the body itself are submitted to analysis.

Quantitative Analysis.—Use for this purpose the precipitated sulphide, digest it in nitric acid, and precipitate the oxide from the solution by potash. One hundred parts of the black oxide correspond to 312 of crystallized sulphate.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms set in from a quarter to half an hour after swallowing the poison, with pains in the abdomen resembling colic, nausea, eructations, vomiting of matters of a bluish or green colour, purging and cramps. Nervous symptoms, such as convulsions, palsy, tetanus, and insensibility, have been present in different cases. As in poisoning by arsenic and mercury, the symptoms are variously grouped in different cases. One symptom of frequent occurrence is jaundice.

Post-mortem Appearances.—The mucous membrane of the stomach and intestines has been found inflamed, ulcerated, thickened, and of a green colour, and in parts apparently gan-

grenous. The salt of copper sometimes adheres to the surface. These appearances occasionally extend to the gullet. The intestines have been found perforated. The skin is yellow. The other post-mortem appearances are not characteristic.

Treatment.—The proper antidotes are albumen, and iron filings. The first is to be preferred. The treatment consists in the free administration of the white of egg, followed by mucilaginous drinks. If vomiting is not present the stomach-pump may be used. The rest of the treatment will vary with the symptoms.

Fatal Dose.—In a case mentioned by Dr. Percival, convulsions were occasioned by two drachms of blue vitriol.

Fatal Period.—The salts of copper have proved speedily fatal. A girl aged sixteen months died in *four* hours after swallowing several fragments of blue stone (Taylor). But death has taken place after long intervals, such as 12, 13, 60, 72, and 78 hours.*

Accidental Poisoning by Copper.—Serious and even fatal accidents have occurred from the use of copper vessels in cooking. The inmates of a monastery suffered severely from obstinate and severe colic, retching, and bilious vomiting, costiveness, flatulence, burning pain in the pit of the stomach, in the kidneys and extremities, and paralytic weakness in the arms. Gmelin traced these symptoms to the fact, "that every vessel in the kitchen, the pots and pans, and even the milk pails and butter dishes for storing the butter, were made of copper." Workers in copper suffer from catarrh of the mucous membrane with which copper, in the form of dust, comes in contact, viz., catarrh of the conjunctivæ, bronchial irritation, anorexia and tendency to diarrhœa. A line described by Corrigan as purple-red, and by Clapton as green, is sometimes observed at the edge of the gums. The hair becomes greenish, and occasionally the same colour has been observed in the perspiration.†

The principal facts established in reference to the impregnation of various fluids and articles of food with copper, in consequence of being prepared or kept in copper vessels, are the following:—Distilled water kept in contact with clean copper is not impregnated with it. Solutions of several saline matters, as common salt, alum, nitre, and Epsom salts, when heated in copper vessels, are found to contain the poison. Acids, and fatty and oily matters, especially when rancid, act still more strongly upon them. One

* Maschka relates a case (Wien. Med. Wochensch. No. 26, 1871) of suicidal poisoning by the sulphate, fatal in 3 days. Jaundice was a prominent symptom. This was attributed to fatty degeneration of the liver, as in arsenical and phosphorus poisoning.

† 'Med. Times and Gazette,' June, 1868.

general principle applies to all these substances—namely, that they may be boiled in clean vessels with comparative safety, but cannot be allowed to stand in them without danger. The contact of air with the moistened copper leads to the formation of the hydrated carbonate, which is dissolved by any acid that the substance may happen to contain. As copper vessels cannot be safely used in cooking without precautions that are apt to be neglected, it would be well to let them fall into disuse.

VI. ZINC, TIN, SILVER, IRON, BISMUTH, CHROME, AND THEIR PREPARATIONS.

ZINC.—Two preparations of zinc require notice—the sulphate and chloride.

Sulphate of Zinc, White Vitriol, White Copperas.—This substance is in common use as an emetic, but is unimportant as a poison. It is found in the form of colourless, or nearly colourless, prismatic crystals, very soluble in water, and of a styptic taste. It resembles oxalic acid and sulphate of magnesia. From the former it is distinguished by tests, for which see oxalic acid; and from the latter by the addition of sulphuretted hydrogen or sulphide of ammonium. The sulphate of zinc yields a white precipitate, but the sulphate of magnesia none.

Sulphate of zinc in solution possesses the following properties:—1. It is precipitated as white sulphide by sulphuretted hydrogen and sulphide of ammonium, provided the solution does not contain an excess of acid. 2. Liquor ammoniæ and the sesquicarbonate throw down a white precipitate soluble in an excess of the precipitant. 3. Ferrocyanide of potassium causes a white precipitate. If the sulphate of zinc contains iron, the precipitates will not be a pure white.

In Organic Liquids.—Sulphate of zinc is decomposed by albumen and milk, which form with the oxide an insoluble compound; and also by substances containing tannin. The first step of the process consists in acidulating with acetic acid, which dissolves any oxide that may be thrown down in union with animal matters. The mixture must then be filtered, and sulphide of ammonium added. A white sulphide is thrown down, which must be washed, collected, dried, and heated to redness in a glass tube. The residue is then to be acted on by strong nitric acid, which dissolves the zinc; and the acid solution, being neutralized by carbonate of ammonia, is ready for the application of the tests. The carbonate of zinc which results from this decomposition becomes yellow when heated, and white again on cooling. It is re-dissolved by excess of the precipitant.

contained in a lotion, were
was no vomiting, and some difficult
emetics. It has been administere
scruples three times a day for sev
consequences. (Dr. Babington.)

The Post-mortem Appearances
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Treatment.—A dilute solution
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Chloride of Zinc.—A concent
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symptoms. It has more than o
occurred in as little as four hours.

TIN.—*Chlorides of Tin.*—Th
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acicular crystals. A mixture o
known as *dyers' spirit.* These
which require notice.

Tests.—The *protochloride* h

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Fig 99.

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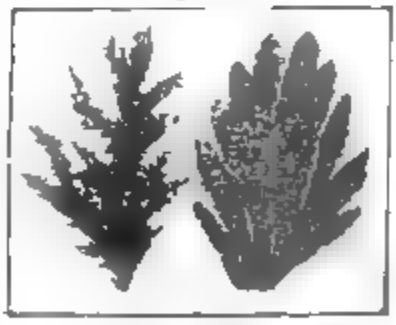
of distilled water gives characteristic results. The acid is detected by the white precipitate, insoluble in nitric acid, thrown down by nitrate of silver.

The *perchloride* is precipitated yellow by sulphuretted hydrogen, and sulphide of ammonium, the precipitate being soluble in an excess of the sulphide. In colour, therefore, the precipitated sulphide resembles the sulphides of arsenic and of cadmium. It differs from the former in being insoluble in ammonia, and from the latter in being insoluble in hydrochloric acid. Corrosive sublimate and chloride of gold give no precipitate with the perchloride. The acid of the salt is detected by nitrate of silver.

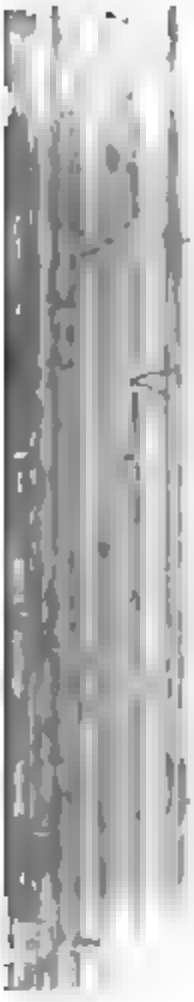
The salts of tin produce the common symptoms of irritant poisoning, which must be met by the free use of albumen or milk, and of diluents. Emetics, or the stomach-pump may be employed if necessary.

SILVER.—*Nitrate of Silver* (Lunar Caustic).—This substance occurs in the form of tabular crystals, or fused into small cylinders. It has the following properties:—It is very soluble in distilled water. Its solution has an acid reaction, and a strong styptic, metallic taste. It is a very powerful corrosive; and, when mixed with organic matter, is blackened by light. The base is detected by the following tests:—1. Sulphuretted hydrogen or sulphide of ammonium yields a black precipitate. 2. Liquor ammonia throws down the brown oxide, which is dissolved by the precipitant in excess. 3. Hydrochloric acid yields a white clotted precipitate, the chloride of silver, which is insoluble in nitric acid, and when heated on platinum-foil fuses into a horny mass. 4. On adding to the solution liquor ammonia, until the brown oxide is redissolved, and then arsenious acid, the yellow arsenite of silver is thrown down. 5. A strip of copper introduced into the solution is speedily coated with silver. 6. If a minute fragment of zinc is placed in a drop of the solution, the metallic silver is deposited in an arborescent form (fig. 100). This test is very delicate, a distinct tree (generally in the shape of the shaded figure) being obtained from a grain in eight ounces of water. The acid is detected by adding to the filtered liquid remaining after the application of the tests, carbonate of potash, when nitrate of potash is formed.

Fig. 100.



Poisoning by nitrate of silver is a rare occurrence. Scatter-



was administered, but repeat
occurred during the first two h
Collapse came on, and death oc
hours after the poison had been

Post-mortem Appearances.—
were erosions of the œsophagus
greater curvature, and similar
and upper part of the jejunum.
of silver adhered to the surface
nitrate had been entirely decom

The *treatment* consists in chan
to the insoluble chloride, by the
salt.

Iron.—The sulphate of iron
chloride, or muriate, of iron pos
to entitle them to rank as poiso
by the following tests:—1. S
precipitate, but the sulphide of
sulphide. 2. Infusion of galls
3. Ferrocyanide of potassium t
which deepens by exposure to
potassium gives a deep blood-red
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tected by the nitrate of baryta a

The *sulphate of iron*, and the
have both proved fatal, and hav
produced severe effects. The sym
nces in one case of poisoning

as it gives no precipitate with dilute sulphuric acid. It gives a deep-brown precipitate with iodide of potassium.

CHROME.—Two salts of chrome—the neutral chromate, and the bichromate of potash—are manufactured on a large scale and extensively used as dyes. The *chromate of potash* has a bright yellow colour, and disagreeable bitter taste. It is the common source of the other compounds of chrome. The *bichromate of potash*, known also as *red chromate*, is much used as a dye. It consists of deep orange-coloured crystals, of the form annexed, or as long flattened prisms. It is very soluble, and yields, according to quantity, a rich orange or a yellow solution, with an acid reaction. With the salts of lead it gives a yellow, and with those of silver a deep-red precipitate. Experiments on animals show that it has the properties of a strong irritant poison; and it has more than once proved fatal to man. In one case, communicated to Dr. Taylor by Mr. Wood of St. Bartholomew's Hospital, two drachms killed a woman in four hours, with symptoms of violent irritation, and the post-mortem appearances of a corrosive poison. The appropriate treatment would be by diluents and demulcents. In solutions of moderate strength the bichromate assumes the forms shown in fig. 101. In dilute solutions ($\frac{1}{100}$) it takes on the

Fig. 101.

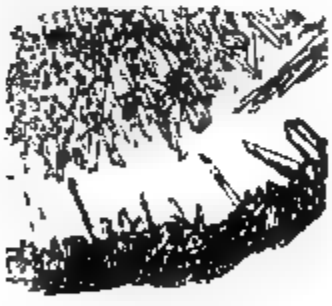
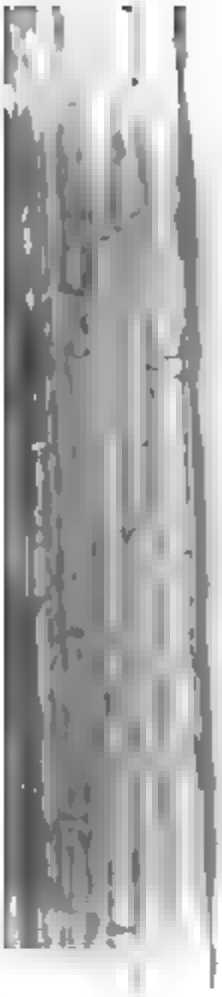


Fig. 102.

arborescent form shown in fig. 102. The crystals from strong solutions are coarse square plates and flattened prisms. The crystalline form of the weaker solution is important, inasmuch as this solution constitutes a very valuable test for strychnia and some other alkaloids.

Workmen engaged in the manufacture of the bichromate of potash suffer much from chronic sores on the hand, and occasionally on the feet and shoulders. The foundation for the sores is laid in some lesion of the skin, on which the poison [illegible]



THALLIUM.—It will suffice to a
as having been proved, by exper
poisonous action.

CHAPTER IX.

NARCOTICS.

OPIUM AND ITS PREPARATIONS.

THE *inorganic poisons* have been treated of in five successive chapters, the remainder of this work will be devoted to the *organic poisons*, beginning with the most important of their number, opium. Of the 543 cases of poisoning investigated in the Coroner's court in England and Wales, during 1837-38, 200 were cases of poisoning by opium and its preparations, either alone or in union with other poisons; 184 having been the number of cases of poisoning by arsenic. Of these 200 cases, 42 were by opium, 133 by laudanum, 21 by other preparations containing opium, 2 by acetate of morphia, and 2 by laudanum and prussic acid, and laudanum and aquafortis respectively: 64 of the 200 occurred in children, the remainder in adults; and of these 64, 41, or a fifth of all the cases, were from over-doses of cordials or medicines, given to infants and young children by mothers or nurses.

Since the years 1837–38, in consequence partly of the legal enactment restricting the sale of arsenic, partly of the increased knowledge of the properties of other poisons, opium and its preparations, which then figured as four in eleven of all the recorded poisons, constituted on the average of the five years 1852-56 more than one-half. The annual average of deaths by ascertained poisons being 268, no less than 141 were attributed to opium and its preparations (opium 34, laudanum 89, Godfrey's cordial 16, morphia 2), while prussic acid and its compounds accounted for 34 deaths, and arsenic and its preparations for only 27 deaths.

In these five years, 1852-56, the ages of the victims were ascertained in 377 instances; and it was found that 170, or nearly half, occurred in infants under one year of age, and 203 in children under five years old. Only one murder and one manslaughter (by laudanum) are reported in the whole five years. But opium and its preparations, and laudanum especially, are sometimes given to facilitate the commission of other crimes, such as theft

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Opium, the inspissated juice o
following familiar properties:—It
a strong and peculiar odour, and
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maturity of the capsules, the great
manufacture, and the presence or
drug consists of a number of distir
peculiar acid, and mixed with

pound kino powder (one grain in twenty); the compound soap pill (one part in five); the lead and opium pill (one part in eight); the ipecacuanha and squill pill (one part in sixteen and a half); and the opium lozenges, which have $\frac{1}{10}$ grain of the extract in each. The vinum opii (twenty-two grains of the extract to the ounce); the enema opii (thirty drops of the tincture in ℥ij of starch); the emplastrum opii (one in ten); the unguentum gallæ c. opio (gr. thirty-two to ℥j); complete the long list of pharmacopœial preparations which contain opium.

The *black drop* said to contain two, three, or four times as much opium as the tincture, and Battley's liquor opii sedativus, of which twenty drops are said to be equal to thirty of laudanum, are also in common use. The first is made with verjuice and aromatics, the second is believed to be an aqueous solution. Godfrey's cordial, Dalby's carminative, children's quietness, and several mixtures improperly given to children to procure sleep, contain laudanum, in variable quantity, as their chief ingredient, in combination with syrups, stomachics, and magnesia.

Opium contains several active principles. Morphia, narcotine, narceine, meconine or opianyl, thebain or paramorphia, codeine, papaverine, and cryptopia, have been separated; but the most important, in a medico-legal point of view, are *morphia* and *meconic acid*, combined in opium as a *meconate of morphia*. Opium may be recognised by the reactions of these two substances, as well as by its odour and other physical properties.

The morphia and meconic acid are extracted and separated by the following process:—The opium is infused in successive portions of cold water. This aqueous solution, holding the active principles of the drug dissolved, is boiled with magnesia, which combines with the meconic acid and carries down with it the active principles. This mixed precipitate is washed and dried, and boiled with proof spirit, which dissolves the narcotine and the resin, leaving the morphia and meconate of magnesia behind.

To separate the *morphia* the precipitate is boiled in strong alcohol, which dissolves it mixed with some resin. From this solution the morphia may be obtained pure by repeated crystallization.

To separate the *meconic acid*, the impure meconate of magnesia is boiled in dilute sulphuric acid, and the mixture partially evaporated. The sediment that falls on cooling is dissolved in water, and acetate of lead added. A meconate of lead is thus formed, which is washed and suspended in water, and a stream of sulphuretted hydrogen gas transmitted through it. Sulphide

Fig. 105.

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Fig. 106.

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medicine. 6. Their solution has
In common with other alkaloids,
its solutions by tannin.

Tests.—These are best applied to

we place a small quantity of the powder on a clean porcelain slab, and dissolve it in a drop of strong sulphuric acid, it undergoes no change of colour, but turns light brown when warmed, and dark brown when heated. If the heat is continued the liquid becomes almost black, and gives off an abundant irritating vapour, having an odour as of singeing. This reaction confirms the effect of heat, and we now prove the powder to be morphia by the following tests, applied as before on a clean slab of white porcelain: 1. Nitric acid. 2. Permuriate of iron. 3. Iodic acid and starch. 4. Sulphuric acid and bichromate of potash.

1. *Nitric Acid.*—This acid dropped on the alkaloid changes it to a rich orange colour, and dissolves it with effervescence, and the production of ruddy fumes of nitrous acid.

2. *Permuriate of Iron.*—This test (which should be neutral) strikes with the powder a rich indigo-blue, turning to green when added in excess.

3. *Iodic Acid and Starch.*—Dissolve a small quantity of the acid in a drop of cold freshly-made starch, place it on the white slab, and introduce the powder or crystal. Iodine is set free, and produces the characteristic blue iodide of farina.

4. *Sulphuric Acid and Bichromate of Potash.*—Cold strong sulphuric acid added to morphia, produces, as just stated, little or no effect; but on adding a solution of bichromate of potash, the mixture assumes a rich brown tint, passing rapidly to green, due to the reduction of the oxide of chromium.

These four tests are delicate and characteristic, and, both separately and collectively, conclusive of the presence of morphia.

Sublimates of Morphia.—Morphia sublimes at the high tem-

Fig. 107.

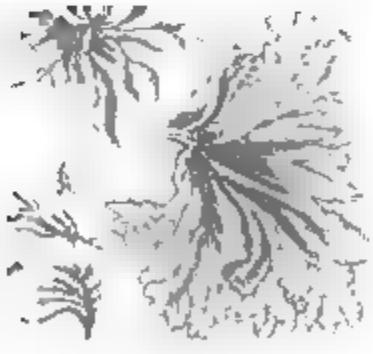
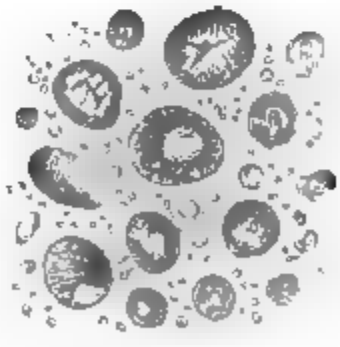


Fig. 108.



perature of 330°, melts when the heat is raised to 340°, and still continues to yield sublimates till it is reduced to a black spot. «

shown in fig. 108. The best rea
of the alkaloid not exceeding the
will yield many successive sublin
and reactions. These, whatever
soluble in several reagents, and
beautiful and characteristic forms

The figures annexed represent
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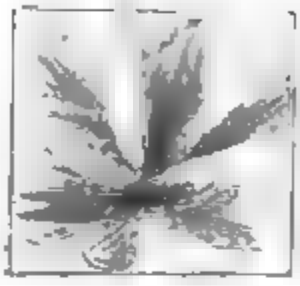
Fig. 109.



× 15.

dilute hydrochloric acid ($\frac{1}{20}$). I
spirits of wine; fig. 111 that wi

Fig 111.

are almost always quick in showing themselves, and are sometimes instantaneous.

MECONIC ACID.—This consists of scaly crystals, which when impure are dusky red, when purer a pale yellow; when quite pure, colourless. Under the microscope they are seen as mottled plates of various sizes, shapes, and thickness. They are soluble in water, and the solution has a strong acid reaction. When heated on white porcelain they readily melt, and assume the form of coarse white plates, and under a greater heat darken, smoke, and melt, yielding a white amorphous sublimate, and leaving a scanty black deposit. The acid is thrown down from its solutions by acetate of lead as a white meconate, insoluble in acetic acid. This substance is not poisonous. The only test of any value for meconic acid, whether in crystals or in solution, is also one of the tests for morphia, viz.:—

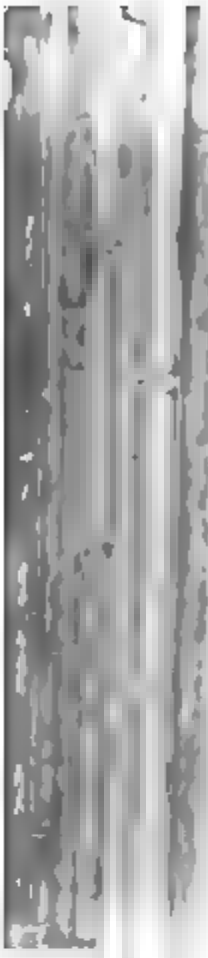
Perchloride of Iron.—This strikes with meconic acid an intense cherry-red colour, discharged by solution of protochloride of tin, but not by the dilute mineral acids, or by the solutions of bichloride of mercury and chloride of gold.

The test gives a similar reaction with sulphocyanide of potassium, with saliva which contains that salt, with common mustard in solution, and with the alkaline acetates; but this fact does not constitute an objection to the test for meconic acid when obtained from a solution of opium, or from an organic fluid by the process now to be described.

This test for meconic acid strongly confirms the tests for morphia as evidence of the presence of opium in the liquid from which they were both obtained.

Opium in Organic Mixtures.—The presence of opium in an organic mixture may be inferred from its yielding with nitric acid the orange colour due to the presence of morphia, and with perchloride of iron the red colour due to the meconic acid. These indications may be obtained by diluting the organic liquid till its colour is such as not to interfere with the reactions.

The process for organic mixtures should obviously be one which separates both the alkaloid and the acid. A solution of opium itself may be regarded as a suspension of its active principles in an organic mixture; for opium, in addition to those principles, contains a large amount of resin and extractive matters. The process for the detection of the morphia and meconic acid in the contents of the stomach is as follows:—The solid matters, if any, are to be cut into small fragments, and well mixed with the liquid, distilled water being added if necessary. The mixture is then to be acidulated with acetic acid, and treated with a



lead, suspended in a little dis
excess of sulphuretted hydrogen
meconic acid remains in solutic
dark red colour by perchloride
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which contains the acetate of m
sulphuretted hydrogen, and any
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rated with carbonate of potash,
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deposits crystals of morphia, whi
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half an hour after an ounce and
taken on an empty stomach, a
mixed up with other odours, tha
certainty.*

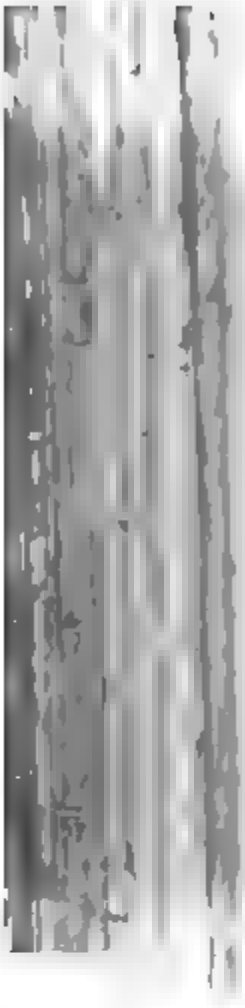
Professor Bloxam recommends

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—There is so much difference in the symptoms present in different cases of poisoning by opium, and at different stages of the action of the drug, that it is impossible to give the history of an average case of poisoning within the ordinary compass of a single description.

The symptoms due to a poisonous dose of opium, or its preparations, are giddiness, drowsiness, and listlessness, followed by stupor, passing by degrees into a state of complete insensibility. The patient lies as if in profound sleep, breathing slowly and almost imperceptibly, with eyes shut, pupils contracted and insensible to light, pulse either very frequent, or full and slow, the skin warm and moist, and the face flushed. At first the patient can be easily roused by loud noises, sudden movements, or slight blows; but, in a more advanced stage, he is kept awake with great difficulty, by violent shaking, loud speaking, tickling the nostrils, injecting water into the ear, or flecking the hands and feet with a towel; and at length falls into a state of complete coma, with stertor, slow and noisy respiration, a slow and full pulse, a pale and ghastly countenance, cold and damp skin, and livid hands and lips. Nausea and vomiting are sometimes present from the first, but in other cases they are among the early signs of recovery. When the patient is kept roused by being briskly moved about, he is subject to constant retching, even though no emetic has been used. The bowels are generally confined. In fatal cases death may take place from apoplexy, in a state of collapse, from apnœa, in convulsions, or in a palsied state. In patients who recover, a long deep sleep, with a remarkably slow breathing (I have counted it in a female as low as 6 in the minute, while the pulse was upwards of 80,) (G.), is followed by a stage of painful nervous excitement, with headache, and distressing nausea.

Occasional Symptoms. — Spontaneous vomiting, diarrhœa, diuresis; delirium, convulsions (most common in children), sometimes alternating with stupor, lock-jaw, and tetanic spasms, paralysis, anæsthesia, dilated pupils, or one pupil dilated, the other contracted, and the reflex function active and easily excited, though the patient is otherwise quite insensible. The *pulse* sometimes nearly natural in frequency and force; in other cases full and quick, but this chiefly in the first stage. In the stage of insensibility, while the patient can still be roused, the pulse is generally full and slow, but towards the fatal termination it becomes small, frequent, and irregular. The respiration is much



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Post-mortem Appearances.
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First Appearance of Sym

by Dr. Gibbs. Twelve drachms of laudanum were spontaneously rejected from the stomach at the end of nine hours, without having given rise to any marked symptoms. The patient was a little exhausted, and the pupils were contracted.

The action of the poison is more prompt when taken on an empty than on a full stomach; when in a liquid state than when swallowed in the solid form; when the patient remains still than when he takes exercise immediately after swallowing the poison; and it is probable that the action is postponed and diminished by spirituous liquors.

Fatal Period.—*Shortest*, three-quarters of an hour. Cases of death in about *two* hours are not uncommon; few cases are prolonged beyond *twenty-four*, and the *average* may be stated at from *seven* to *twelve* hours. When a patient survives *twelve* hours there is good hope of recovery.

Fatal Dose.—Smallest, about four grains. A quantity of the extract equivalent to four grains of opium has destroyed life. Enormous quantities have been taken with impunity. In one instance recovery took place after no less than eight ounces.

In very young children extremely small doses produce very marked effects, and have proved fatal. An eighth of a grain of opium, or its equivalent, has killed an infant two days old, a sixth of a grain one of four, and another of five days, a fifth of a grain one of three days old, a third of a grain one of nine months, and another a few weeks old, a fourth of a grain a child of fourteen months, less than half a grain a child of four years and a half. Two drops of laudanum killed an infant. Severe symptoms have been produced by a single grain of Dover's powder, containing a tenth of a grain of opium. A child of four months, and several infants, have suffered severely from quantities of laudanum equivalent to the sixth of a grain of opium.*

Death has happened, in the instances referred to, in intervals of time varying from 7 to 18 hours. As in the adult, so in infants and young children, recovery has taken place after considerable doses of opium. In a case under my own observation a child of six months recovered from ten grains of Dover's powder. (G.)

There are some persons on whom small doses of opium and its preparations, through peculiarity of constitution, produce unusually severe effects. On the other hand, the habit of taking opium lessens the effect of the poison.

Opium, like tobacco, may be taken in constantly increasing doses with impunity. Thirty, and even one hundred grains, of

* For details of such cases, with the particular preparations given see the standard works on Toxicology.

solid opium are often taken in the day by opium-eaters; and De Quincey, the English opium-eater, brought himself to take nine ounces of laudanum, equivalent to 333 grains of solid opium, in the day. Mr. Image, of Bury St. Edmund's, has supplied me with the particulars of two cases that came under his observation, in which the enormous quantity of sixteen ounces of laudanum per diem was consumed. Yet both these persons lived to an advanced age. There is scarcely a druggist in London who has not seen laudanum swallowed by the wineglassful; and I am informed that the Lascar beggars purchase half an ounce of opium a day, from which they procure a watery extract to smoke with tobacco. (G.)

Opium, thus taken habitually in large quantities, and for long periods, causes emaciation and loss of vigour, loss of appetite, and constipation, loss of mental vigour, severe neuralgic pains, premature old age, and early death. Hobhouse describes the opium-eaters of Constantinople as "pale, emaciated, and rickety, sunk into a profound stupor, or agitated by the grimaces of delirium." Mr. Madden and Dr. Oppenheim confirm this account. The former adds, that a regular opium-eater seldom lives beyond thirty years, if he commences the practice early; and the latter tells us that such persons seldom attain the age of 40.

In the face of these statements, and of the extreme improbability that a habit so unnatural should not affect the duration of life, it has been denied that the practice of opium-eating tends to shorten it. There is no doubt that many persons who indulge in it (but in a less degree than in the cases referred to by Hobhouse, Madden, and Oppenheim), live to a good age; but it is probably with opium as with spirits and tobacco.—those who indulge in them and live long would attain a much greater age if their habits of life were other than they are.*

Opium applied to the skin, and especially to an abraded surface, or used as an injection, or introduced into the nostril or ear, may produce dangerous or fatal results. M. Tournon, of Bordeaux, relates a case in which death was attributed to four grains of opium introduced into the ear.

Treatment.—The treatment must begin with the use of the stomach-pump, and warm water should be freely injected and withdrawn till it is discharged without odour and colour. If the stomach-pump cannot be immediately applied, an emetic of sulphate of zinc should be given; or, if this is not at hand, a tablespoonful of mustard, mixed with water. At the same time vomiting should be encouraged by the free use of warm water, and by

* For cases, see Christison on the case of the Earl of Mar, p. 661.

tickling the throat with a feather. If the patient is comatose, cold water should be freely dashed over the face, head, and neck, till he is somewhat roused from the stupor, and he must then be kept awake by causing him to walk rapidly between two assistants, shaking him and shouting to him. In small apartments he may be kept roused by flecking the hands and feet with a towel. When he begins to recover, strong coffee should be freely given. If emetics by the mouth do not act, they may be injected into the bowels, and, in hopeless cases, a solution of tartar emetic might be introduced into a vein. A current of magneto-electricity passed from the spine through the chest, and artificial respiration, have been used in extreme cases. When the symptoms present are those of collapse, ammonia may be freely given internally and applied to the nostrils; when those of apnœa, warmth and friction to the surface are indicated; when those of cerebral congestion, the moderate abstraction of blood by leeches. In the excited state which follows recovery, as well as in the early stage, cold affusion has been practised with excellent effect.

Some of the reagents which precipitate morphia from its solutions have been proposed as antidotes. Orfila recommended tannic acid, and solutions of iodine and bromine have been suggested. The proposal to administer iodine in dilute solution has been revived by Dr. Fuller. ('Lancet,' March 21, 1868.)

As narcotism (the common effect of opium) and delirium (the leading symptom of belladonna poisoning) are strongly contrasted conditions, it has been inferred that the one poison would prove an antidote for the other. Accordingly two American physicians, Drs. Horton and Norris, have published cases of recovery from poisoning by opium which have seemed to be due to the use of belladonna, and of poisoning by belladonna thought to be equally due to the employment of opium. Dr. John Harley concludes from his experiments that morphia and atropia, so far from exercising an antagonistic influence on each other, increase each other's effects. On the other hand, numerous cases have been reported which seem to show that the subcutaneous injection of atropia has proved beneficial, and that within certain limits the two substances exert a physiological antagonism. The subcutaneous injection of atropia in cases of opium poisoning is therefore at least worthy of trial. On this subject the reader may refer to the following:—A case of successful antagonism reported by Dr. Wilson, of Philadelphia ('Lancet,' 1861, i. 473); a similar case by Dr. Carter ('Phil. Med. Times,' 1871, p. 277); a case of antagonism reported by Dr. Finny ('Dublin Journ. Med. Sc.,' July, 1872, p. 38); and reports of similar treatment

in 'London Med. Rec.,' 1873, p. 218, and 827. The researches of Little ('Phil. Med. and Surg. Rep.,' xxiv. p. 334); Reese ('Amer. Journ. Med. Sc.' lxi. p. 133); and Fraser ('Trans. Roy. Soc. Edin.,' 1872, xxvi.) on the physiological antagonism of poisons are deserving of study.*

MORPHIA AND ITS SALTS.

Of this alkaloid, which is found in opium in proportions varying from 2 to 23 per cent., the best kinds averaging about 10 per cent., there are two salts—the acetate and hydrochlorate—which supply preparations to the British Pharmacopœia—namely, the liquor morphiæ acetatis and the liquor morphiæ hydrochloratis, which contain one grain of the salt in 2 drachms. Also the suppository, which contains half a grain of the hydrochlorate, and the lozenge of morphia, as well as the compound lozenge of morphia and ipecacuanha, containing in each lozenge the 36th of a grain. The hydrochlorate is the preparation in most common use, and its ordinary dose for an adult is an eighth of a grain. The acetate is sold as a snow-white powder, or imperfectly formed crystals; and the hydrochlorate either as a white powder, or in the form of silky acicular crystals. A solution for the purpose of hypodermic injection is now officinal. These salts have the chemical reactions of morphia itself.

Symptoms.—Those of opium and its preparations. The symptoms set in somewhat earlier, and contraction of the pupils, with great dimness of vision or actual blindness, is very constant. Intense itching of the skin is also very common, and dysuria, tetanic spasms, and strong convulsions are among the occasional symptoms.

Anomalous Cases.—In one case reported by Dr. Shearman,† a grain and a half of the acetate of morphia in divided doses caused twitching of the limbs and face, difficulty in swallowing, spasms of the muscles of the arms, legs, and abdomen, partial opisthotonos, and great activity of the reflex function. Morphia was found in the urine. The patient recovered. A similar case of poisoning by twenty-two grains of the muriate of morphia, in which locked jaw, tension of the abdomen, and occasional convulsions, were present, is related by Orfila, and cited by Christison (p. 725). In one case, also, delirium seems to have followed its application to a blistered surface.

It is worthy of observation that Auguste Ballet, the presumed

* See an abstract of Dr. Harley's Lectures in the 'Pharmaceutical Journal,' April, 1868, p. 471.

† 'Med. Times and Gazette,' March 7, 1857.

victim of Castaing, had, in addition to vomiting and purging, convulsions, locked jaw, rigid spasms of the neck and abdomen, inability to swallow, loss of sensibility in the legs, contracted pupils, and stertorous breathing; and that Castaing, who prescribed for Ballet, and gave him food and medicine, was proved to have recently purchased twelve grains of tartar emetic, and twenty-six grains of acetate of morphia.

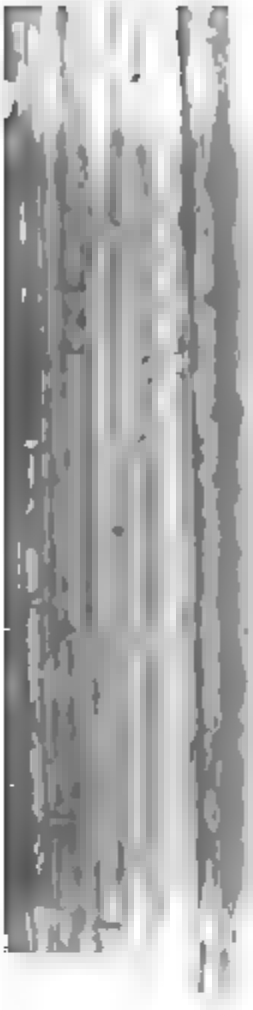
John Parsons Cook, the victim of William Palmer, took two pills containing half a grain of acetate of morphia on each of the two nights preceding his first attack; and on the night of the attack itself two pills were given by Palmer, and again two pills on the occurrence of the tetanic symptoms. On the succeeding night, which was the night of his death, Cook also took two pills given him by Palmer, who had previously obtained the acetate of morphia pills from the medical attendant; and during the fatal attack two other pills, said to contain ammonia. If all these pills contained acetate of morphia in the dose first prescribed, an aggregate of three grains would have been given within three days, of which quantity two grains were administered in little more than twenty-four hours. As the lady attended by Dr. Shearman was severely attacked with symptoms of tetanus from taking three doses of half a grain of acetate of morphia within seven hours, it is quite possible that the same drug in the same dose, and in the aggregate three grains in the space of seventy-two hours, may have proved fatal to a patient previously reduced by tartar emetic. It is not intended by these observations to raise any doubt of the guilt of Palmer, but merely to suggest the possibility of the death of Cook having been occasioned by acetate of morphia and not by strychnia. (G.)

Fatal Dose.—In the case of this, as of most other active poisons, very large doses have been taken with impunity, and very small ones, in certain states of system, have been followed by dangerous symptoms. In one case half a grain of the acetate of morphia given as a medicine to a female in ill health was supposed to have proved fatal,* and it is probable that less than a grain given in one dose would kill an adult. One grain injected under the skin in three doses of one-third of a grain each, within about twelve hours, appears to have proved fatal to a man under the care of Mr. de Morgan.†

Treatment.—That proper to poisoning by opium and its preparations. The stomach-pump should be employed without delay. If not at hand, finely divided animal charcoal suspended

* 'Lancet,' Nov. 1838.

† Taylor's 'Principles and Practice of Medical Jurisprudence,' p. 251.



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CHAPTER X.

DELIRIANTS.

1. BELLADONNA.
2. HYOSCYAMUS.
3. STRAMONIUM.
4. SOLANUM NIGRUM.
5. SOLANUM DULCAMARA.
6. SOLANUM TUBEROSUM.

7. CAMPHOR. 8. ŒNANTHE CROCATA. 9. COCCULUS INDICUS.
10. LOLIUM TEMULENTUM. 11. POISONOUS FUNGI.

THE poisons belonging to this group are characterized by the common property of causing delirium, with illusions of the senses; coupled with extreme dilatation of the pupil. Other poisons which affect the nervous centres either do not give rise to delirium, or they produce it only exceptionally; and, if they dilate the pupil, it is less constantly, and in a less degree. Irritation of the stomach and bowels, and dysuria, or suppression of urine, are present in a certain number of cases. The first three poisons are the most important of their class; the others have less interest, and are more briefly noticed; the reader being referred for more ample details respecting them to treatises on toxicology.

1. BELLADONNA (*Atropa Belladonna, Deadly Nightshade*).

This plant is of the Linnæan class and order, *Pentandria Monogynia*, and natural order, *Atropaceæ*. It is indigenous, and grows in waste shady spots in some parts of England, flowering in June and July, and yielding ripe berries in September. Fig. 113 shows a cutting of the plant in flower, and a berry, whole and in section. The plant has a lurid hue, and when bruised, gives out a faint fœtid odour. Cases of poisoning by the *root*, *leaves*, and *berries*, and by the medicinal *extract*, are on record, several of which proved fatal. A decoction of the root, given as a clyster, has also caused death; and serious symptoms have followed the external application of the extract to a blistered surface. The leaves and root of the plant are admitted into the

dried and it has a slightly bitter
unequal size, ovate and undivid
to the stem by short foot-stal
small cherry, with a deep cer
colour, and sweetish taste, are
and have two cells, containing se

portions of them will be found, in cases of poisoning, in the matters rejected by the stomach, or passed from the bowels.

Symptoms.—Dryness of the lips, mouth, and throat, with difficulty of swallowing, or even total inability to swallow, and impaired utterance, or loss of voice; thirst; giddiness; numbness of the limbs; staggering gait; great mental excitement; delirium, gay or furious, with spectral illusions, ending in coma, or alternating with it; the pulse accelerated; the countenance flushed and swollen; the pupils largely dilated; the eyes prominent and sparkling; the vision indistinct or lost. In fatal cases, death is ushered in by comatose symptoms, rarely by convulsions. Irritation of the alimentary canal, beyond dryness and constriction of the throat, is rare; but nausea and unsuccessful efforts to vomit are recorded in some cases, and aphthous inflammation of the throat, swelling of the abdomen, and discharge of blood by stool, in at least one instance. Violent strangury, suppression or involuntary discharge of urine, with excitement of the genitals, and hæmaturia, and an eruption on the skin, said to resemble that of scarlatina, have also been reported.

The symptoms may set in within half an hour; but they rarely show themselves till two or three hours after swallowing the poison. The fatal cases bear a small proportion to cases of recovery. Death, when it occurs, takes place within twenty-four hours. In one case it happened in fifteen, in another in twelve hours. In favourable cases the effects often last for several days; and some of the leading symptoms, such as impaired vision, and greatly dilated pupil, survive the patient's recovery.

Delirium is generally a very marked symptom. It is sometimes pleasing, accompanied by uncontrollable laughter, or by incessant talking, sometimes only by voiceless motions of the lips; uniformly by spectral illusions. In some instances the state of the patient closely resembles somnambulism, in others intoxication, in others hydrophobia; the extreme dilatation of the pupil is accompanied by indistinct or double vision, or by blindness. He is generally unconscious, and, on recovery, does not recollect what has happened. The delirium commonly precedes the sopor or coma; but sometimes the order is reversed, or the two states alternate. *Trismus* and *subsultus tendinum* are of occasional occurrence.

Post-mortem Appearances.—These are neither strongly marked nor characteristic. The cerebral vessels are congested, and there are red patches in the pharynx and œsophagus, and at the cardiac end of the stomach. The mucous membrane has been found of a dark purple colour throughout, or in patches, and portions of the

berries and some of the seeds have been detected in the intestinal canal or in the stools.

Treatment.—After the prompt use of emetics, animal charcoal diffused through water, or diluted liquor potassæ, and after an interval, a full dose of castor oil. In other respects it will be determined by the symptoms actually present. Bleeding may be practised with advantage.

What has been said respecting opium is applicable to belladonna, namely, that there is reason to believe that much good may be done by the use of the one drug as antagonistic to the other. In belladonna poisoning, therefore, the subcutaneous injection of morphia may be recommended.

Experiments on Animals.—Belladonna acts differently on different animals. It acts powerfully as a poison on the carnivora; while many herbivorous animals, such as the ox, the ass, the rabbit, can eat it with impunity. Its action on other mammals is similar to that observed on man; but it acts on the frog in a peculiar manner. According to the researches of Fraser the animal is first paralysed, and some hours after the administration of the poison appears quite dead, muscular irritability and slight action of the heart being the only signs of life. After a period of from 48–72 hours the fore limbs are seized with tetanic spasms, which gradually develope into complete tetanus, closely resembling that caused by strychnia. The symptoms in man are in some respects explained by the effects observed on animals. The mode in which it acts on the brain to cause delirium is obscure. Fraser thinks the action on the spinal cord is first paralysing and then exciting. Belladonna paralyses the secretory nerves; hence the dryness of the mouth which is so characteristic an effect of the poison. It also paralyses the vagi, the inhibitory nerves of the heart; partly explaining the great rapidity of the pulse in belladonna poisoning. The interference with vision is due both to the dilatation of the pupil and paralysis of the muscles of accommodation. The exact cause of these phenomena is still a matter of dispute.

The *diagnosis* is not free from difficulty; for similar symptoms are present in poisoning by hyoscyamus and stramonium. It is only when we discover some portion of the plant itself in the substances rejected from the stomach, or passed from the bowels; or, in a fatal event, in the contents of the alimentary canal, that we can state with confidence which poison has been taken. The description given of the part of the plant swallowed may, however, prove decisive. The berry is easy to recognise. It happens fortunately that the alkaloid atropia is eliminated from the kidneys, and can be de-

tected by its action on the pupil. Dr. John Harley has repeatedly proved the presence of atropia in the urine by this means within twenty minutes of the injection under the skin of $\frac{1}{48}$ or $\frac{1}{96}$ grain of the sulphate. Twelve drops out of eight ounces of urine secreted in $2\frac{1}{2}$ hours by a patient under the influence of $\frac{1}{48}$ grain will largely dilate the pupil, and maintain it in that state for several hours. One or two drops of urine are to be introduced between the eyelids every quarter of an hour till the effect is produced.

ATROPIA (*Atropine*).—This alkaloid, when pure, consists of white silky crystals, which, when viewed under the microscope, are four-sided prisms. It belongs to the group of alkaloids which does not change colour when treated with cold sulphuric acid. It also undergoes no change when the acid is warmed, but assumes a deep brown tint when heated. Its colour is not changed by nitric acid. When heated on porcelain it melts easily into a pale liquid, yields a vapour which has an odour as of singed wool, and leaves a light brown stain. It melts at the low temperature of 150° Fahr., and sublimes at 280°. The sublimate is crystalline, but less constant and characteristic than those of strychnia and morphia. It is soluble in water, alcohol, ether, chloroform, and benzole; also in dilute acids, with which it forms crystallizable salts. With liquid reagents it yields few characteristic precipitates. With carbazotic acid and chloride of gold it yields abundant precipitates, which assume respectively the forms of beautiful clusters of plates, and distinct foliated groups.*

II. HYOSCYAMUS (*Hyoscyamus niger, Henbane*).

This, too, is a plant of the Linnæan class and order *Pentandria Monogynia*, and natural order *Atropaceæ*. It is indigenous, and grows on poor waste lands, and on the sea-shore. Fig. 115 shows a cutting of the plant, a flower, and a seed-vessel. All parts of the plant are poisonous; and the seeds, root, leaves, and young shoots have been taken as poisons.

The poisonous property of the plant is attributed to an alkaloid, *hyoscyamia*, and a peculiar volatile principle.

The leaves are in the British Pharmacopœia, and furnish two preparations—an *extract* and a *tincture*.

The several parts of the plant are easily recognised. The *seeds* are about the size and shape of those of Belladonna, but less rounded; about an eighteenth of an inch in diameter, and weighing 120 to the grain. They are thickly covered with ridges

* Wormley, Pl. xiii. figs. 1 and 2.

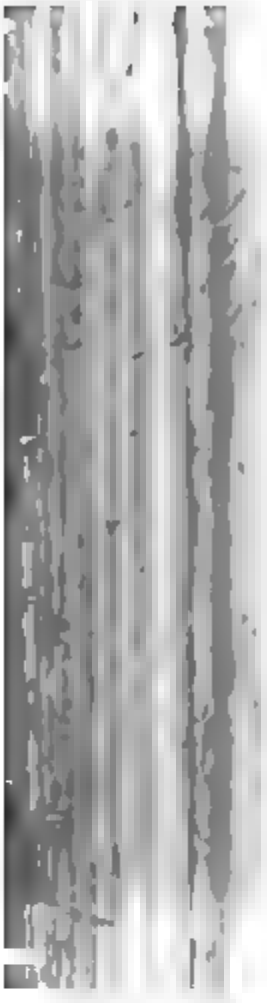
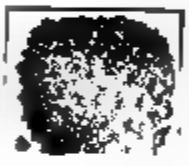


Fig. 110.



pear in from a fe
consist of flushi
pulse, weakness
stable gait, pas
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of diet, we are best acquainted with the symptoms as affecting several persons simultaneously.

The most characteristic symptoms are *delirium* and *dilated pupils.*

Post-mortem Appearances.—Congestion of the brain and lungs.

Treatment.—That of poisoning by belladonna.

Experiments on Animals.—On some animals, such as the sheep, the cow, and the pig, hyoscyamus seems to have little or no effect. Only quite recently the action of the poison has been studied by Oulmont and Lamart and Boehm on frogs, rabbits, Guinea pigs, cats, and dogs. The effects are similar to those on man, especially in the paresis or paralysis of the lower extremities. In other respects the action is similar to that of belladonna.

A poultice of the leaves applied to the abdomen, and a decoction used as a clyster have produced poisonous effects.

HYOSCYAMIA (Hyoscyamine).—M. Stas appears to have succeeded in obtaining this alkaloid; but the best manufacturing chemists, and notably Mr. Morson, have been unsuccessful. It is said to be either amorphous, or to consist of white silky crystals; to be without odour when pure; but, as generally obtained, to have a very disagreeable odour, like that of tobacco, and an acrid taste. A specimen kindly sent to me by Dr. John Harley is a pale, rose-coloured, deliquescent extract, little changed by sulphuric acid, but turned to a red-brown when the acid solution is warmed. Heated on porcelain, it darkens, smokes, and yields a bulky black ash; and a sublimate containing numerous delicate feathered crystals. Dr. Harley finds that it quickly passes into the urine, from which it may be separated by shaking it with chloroform, and identified by its action on the pupil. (G.)

III. STRAMONIUM (*Datura Stramonium, Thorn-Apple*).

This also is a plant of the Linnæan class and order *Pentandria Monogynia*, and natural order *Atropaceæ;* growing in waste places and on dung-heaps in all parts of Europe. The annexed figure shows a cutting of the plant with sections of the flower and fruit. The entire plant has a rank odour. The flowers, however, are sweet-scented. The *leaves* are of a dull green colour, large, sharply and irregularly cut at the edges, smooth, ribbed, and veined. Every part of the plant is poisonous; but the fruit and seeds are believed to be the most active. The vapour of the flowers is asserted to have produced poisonous effects. In France and Germany, as also in India, and the Eastern Archipelago, the seeds of this or of other species are

given to aid the commission of crime. Cases of poisoning by the leaves, fruit, seeds, and extract are on record; and dangerous symptoms have been occasioned by their external application. It is smoked with or without tobacco as a remedy for asthma.

Fig. 117.

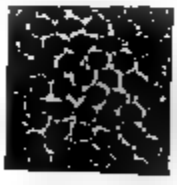
Stramonium owes its poisonous properties to an alkaloid, known as *daturia*.

The leaves and seeds are in the British Pharmacopœia, and the seeds supply an extract and a tincture.

The *fruit*, or apple, the size of a walnut, has a strong prickly outer coat. The *seeds* are light brown or black, circular or kidney-shaped, flattened, with a corrugated surface. They are much larger than those of henbane or belladonna; for while the seeds of henbane weigh 120, and those of belladonna 90 to the grain, there are only about eight stramonium seeds in one grain. The size, and the microscopical appearance of the cuticle of the seeds, are shown in fig. 118.

Experiments on Animals.—The effects produced by stramonium are those of belladonna and hyoscyamus. In common with them, it largely dilates the pupil.

Fig. 118.



Symptoms.—These nearly resemble those of poisoning by henbane and the deadly nightshade; but they begin sooner, and are more severe than those of poisoning either by henbane or deadly nightshade. Delirium may be present in fifteen minutes, and death take place in seven hours. There are dryness of the throat, flushing of the face, dilated pupils, delirium, with spectral illusions, accompanied by convulsions and followed by coma, and, in some instances, irritation of the alimentary canal.

Post-mortem Appearances.—In some cases congestion of the

vessels of the brain, and in one instance redness of the cardiac end of the stomach.

Treatment.—This consists in the prompt use of emetics, followed by full doses of castor oil; and where there is much flushing of face, the abstraction of blood from the arm, or by leeches to the temple. In one case reported in 'Rust's Magazine,' bleeding appears to have afforded great relief, and would seem to be equally applicable in poisoning by henbane and deadly nightshade, and in cases of poisoning generally where the face is flushed and the eyes prominent and brilliant. The use of morphia as an antidote is worthy of trial, as in poisoning by belladonna or hyoscyamus.

Daturia.—This alkaloid is believed to differ very little in its composition and properties from atropia; like it, it is found in silky crystals, which are four-sided prisms. It produces the same effect on the pupil of the eye as the alkaloids atropia and hyoscyamia. Schroff states that daturia is more powerful than atropia.

The *diagnosis* of poisoning by stramonium is effected by the discovery of portions of the plant in the alimentary canal, or in the matters vomited or discharged from the bowels.

IV. SOLANUM NIGRUM (*Black, or Garden Nightshade*).

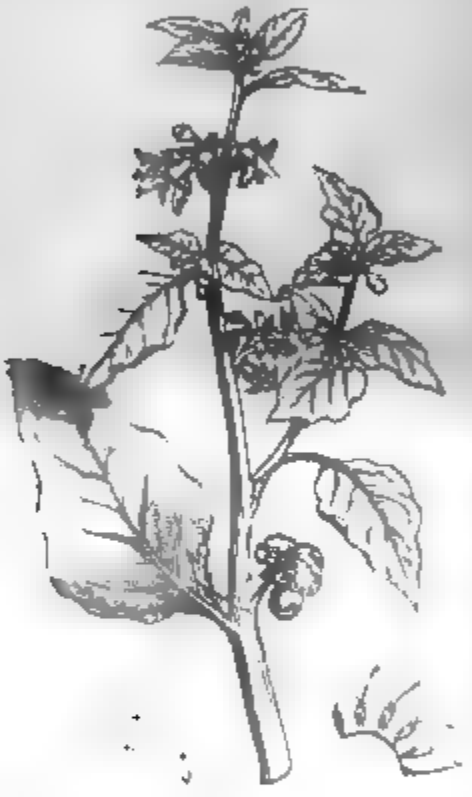
This is an annual plant, common in gardens, by roadsides, and near manure-heaps, growing to a height of one or two feet, and bearing small white flowers, and berries which, when ripe, are black. Fig. 119 shows a cutting of the plant, with flowers and berries. The berries and leaves of this plant have been eaten by children, and have given rise to symptoms allied to those of the three poisons placed at the head of this chapter—symptoms of intestinal irritation (nausea, vomiting, colic pains and intense thirst), and cerebral symptoms (delirium, restlessness, convulsions, tetanic spasms, and extreme dilatation of the pupil).

The *symptoms* are well described in two cases cited by Tardieu from M. Magne, who ascertained beyond doubt that they were due to the leaves of the solanum nigrum.

At some time between 5 and 7 P.M., two children, 3½ years of age, ate the leaves, and about eight o'clock began to show symptoms of poisoning. One child died, the other recovered. In the child who died there was pain in the belly, gradually increasing, and attended by nausea without vomiting, then restlessness followed by delirium. These symptoms increased till towards midnight, when the child was so restless and delirious as to be with difficulty kept in bed. When seen by M. Magne, he found

the belly greatly distended, the pulse very quick and scarcely perceptible, the respiration hurried, the face pale, and the pupils enormously dilated. The limbs were convulsed, the child became insensible, and sank about twelve hours after taking the poison. The child who recovered passed the whole night restless, and sleepless, frightened, and troubled with illusions. When seen by M. Magne she was asleep, with natural pulse and respiration; but on the second visit was awake and sitting up in bed, her face expressive of astonishment and fright, her pupils dilated to the utmost and fixed, but she soon began to recognise her parents, fell into a deep but disturbed sleep, and recovered in about twenty-four hours, though the pupils still continued dilated.

Fig. 119.



V. SOLANUM DULCAMARA (*Woody Nightshade* or *Bitter-sweet*).

This is one of the most common plants of our hedges and roadsides, growing to many feet in length, and twisting among the branches of trees. It begins to flower in June, and continues to produce flowers and berries till late in autumn. Its purple petals with rich yellow stamens, and bright red berries, make this plant one of the ornaments of our hedgerows (fig. 120).

The red berries of this plant do not appear to possess the active properties of the black berries of the solanum nigrum, though they prove more attractive to children. They proved fatal to a boy, four years of age, while two older sisters, who ate them at the same time, suffered slightly or not at all. The symptoms in this fatal case were vomiting and purging, convulsions, and insensibility alternating with each other, and death in convulsions.* The evidence as to the poisonous properties of the berries of this plant, and their degree of activity, is very conflicting, and the

* 'Lancet,' June 28, 1856, p. 715.

case just cited is not free from the suspicion that some of teh black berries of the solanum nigrum were eaten at the same time.

Fig. 120.

VI. SOLANUM TUBEROSUM (*the Potato*).

The berries of this plant, and young shoots, possess poisonous properties, and the berries have proved fatal. In the case of a young lady æt. 14, reported by Mr. Morris, of Merford,* there was great restlessness, anxiety, and jactitation; the skin was livid and covered with a cold, clammy perspiration, the respiration hurried, the pulse very quick and weak, the jaws contracted, the speech lost, the tongue covered with a dark brown moist fur; and the patient constantly spat a viscid froth through the closed teeth. She died on the second day.

SOLANIA (*Solanine*).—This alkaloid, not being used as a medicine or poison, is chiefly interesting as the active principle of the solanum nigrum and dulcamara, and of the potato, from the berries and young shoots of which it is obtained. It is sold as a white powder; but may be extracted in the form of delicate acicular crystals. It belongs to the group of alkaloids which is changed in colour by cold sulphuric acid. It assumes, with this reagent, a bright yellow tint, changing to brown when warmed, and assuming a deeper tint of brown when heated. It is not changed in colour by nitric acid. When heated on porcelain, it discolours, melts slowly, gives off a dense vapour which has the odour of baked apples, and swells into an abundant carbon. It sublimes at 420° Fahr., and deposits on the glass disc the characteristic long needles, variously crossed and interlaced, shown in the annexed figure. It is sparingly soluble in water, but soluble in acids; soluble in alcohol, but insoluble or sparingly soluble in benzole, ether, chloroform, and amylic-alcohol. Its liquid reactions are mostly of a negative character; it yields no precipitate with most of the reagents that give abundant and often characteristic

Fig. 121.

× 50.

* 'British Medical Journal,' 1859, p. 719.

crystals with several other alkaloids. From its alcoholic solution, and as sulphate, it is deposited as delicate needles, crossed and interlaced, or radiating from a point.*

Experiments on Animals.—The action of solanine still requires investigation. According to the researches of Clarus and others large doses of solanine cause vomiting, quickening of the respiration and circulation, and a parosis of the lower extremities. Death occurs with excessively weak and rapid pulse, and occasionally with convulsions. Experiments on man have shown that it has a similar effect on the circulation and respiration, and causes dry skin, nausea, and great prostration. It does not cause dilatation of the pupil.

VII. CAMPHOR.

This substance is decidedly poisonous, but has only proved fatal in a few instances.

Properties.—It is a colourless, translucent, and semi-crystalline substance, of a tough texture, strong and peculiar odour, and pungent yet cool taste. It floats on water, in which it is sparingly soluble, evaporates at common temperatures, and is deposited on cool surfaces (as on the inside of bottles) in crystals. It is readily dissolved by alcohol, ether, chloroform, and the volatile and fixed oils. It imparts its peculiar odour to the breath.

When taken as a poison it is usually in fragments, and being sparingly soluble in the contents of the stomach, would be easily identified. If dissolved in spirit, it may be separated by distillation, and thrown down by the addition of water.

Symptoms. These begin with languor, giddiness, dimness of vision, and confusion of intellect, followed by depression, intoxication, or violent delirium. Convulsions also occur, especially in children; and there is much excitement of the circulation, with heat of skin, flushed face, hurried pulse, and dilated pupil. Recovery takes place after a long, deep sleep.

In a case given by Klingelhoffer (abstract in 'Lond. Med. Rec.,' vol. i p. 654), a woman took 30 grains of camphor, and immediately complained of giddiness, which rapidly increased, followed by headache, burning pain in the stomach, eructations, and great thirst, and formication in the extremities. Six hours after she was seen with pallor and coldness of the face and extremities, and small and irregular pulse. The giddiness and tremor had passed away, but there was constant movement of the hands. Next day, under the influence of treatment, she recovered.

* Wormley, Pl. xiii. figs. 5 and 6.

Mr. J. C. Bellamy, of Plymouth, communicated to me the following account of the effect on himself of twenty grains of camphor dissolved in spirit. Giddiness came on almost immediately, he fell into a chair, had a series of fits of uncontrollable laughter, followed by extreme faintness and cramps. Then ensued nearly complete paralysis, the voice being reduced to the faintest whisper. This state continued several hours, and left behind it great debility. The mind was not affected. (G.)

Post-mortem Appearances.—These, as observed in animals, are inflammation of the stomach and bowels, injection of the membranes of the brain, and inflammation of the urinary passages. The odour of the poison pervades the whole body.

Smallest fatal dose.—Twenty grains have produced serious symptoms in an adult male, and thirty grains have killed an infant eighteen months old, in seven hours.

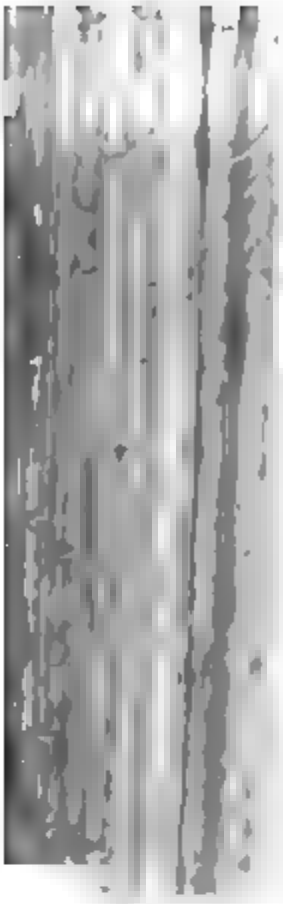
Treatment.—This consists in the prompt use of emetics, followed by castor oil as a purgative. The discharge of the contents of the stomach is generally followed by speedy relief.

VIII. ŒNANTHE CROCATA (*Hemlock Water Dropwort*).

Fig. 122.

This is an indigenous umbelliferous plant, growing on the banks of streams and ditches, and bearing some resemblance to celery (fig. 122). All parts of it are poisonous; but the root, from a rough resemblance to the parsnep, is generally the part eaten by mistake; and is so virulent a poison that a very small piece of it has proved rapidly fatal.

The *symptoms* may set in as soon as twenty minutes after swallowing the poison, with convulsions and insensibility, livid, bloated face, mouth and nostrils covered with bloody foam, and stertorous respiration; and death may follow in as little as five minutes from the first seizure. In more protracted cases severe nervous symptoms show themselves, consisting of locked jaw,



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IX. COCCULI

This is the berry of a
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Fig. 123.

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and spirits. It is used with
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The *symptoms* are those
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PICROTOXIA (*Picrotoxin*
prismatic crystals, which hav
to the group of active princi
cold sulphuric acid; but the

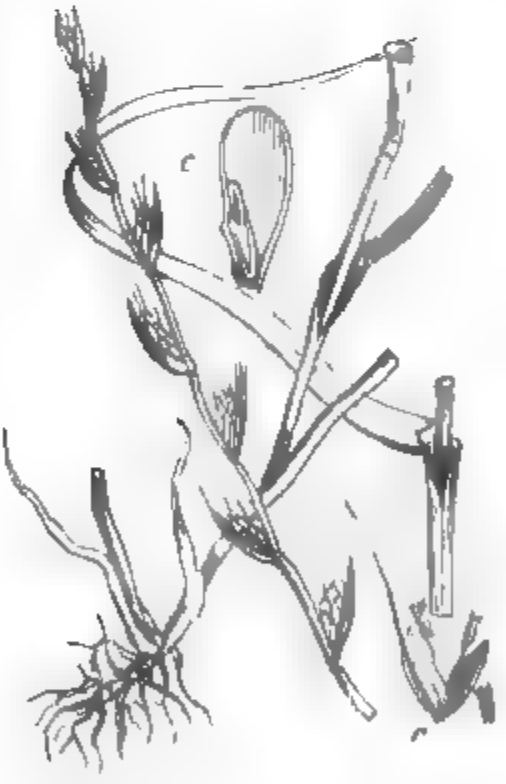
with hydrochloric acid, and then shaking the liquid with ether which holds the poison in solution, and deposits it as crystals. This method has been practised with success by Mr. Langley.*

Experiments on Animals.—The leading symptoms caused in animals by picrotoxine are vomiting and convulsions. In rabbits it retards the pulse, quickens the breathing, and causes opisthotonos and convulsions. Roehe has carefully investigated its action on frogs. In them, after a short interval of stillness, it causes tetanic spasms, and then clonic convulsions of a most marked character. A peculiar inflated condition of the lungs is also produced, due to a sort of inspiratory tetanus. Its effects are attributed to irritation of the medulla oblongata.

X. LOLIUM TEMULENTUM (*Darnel*).

The seeds of this plant are sometimes mixed with other grains used for distillation, or ground into flour for making bread. When so used, they may produce marked symptoms of poisoning, including heat of throat, headache, giddiness, staggering as if from intoxication, strong tremulous movements of the limbs, impaired vision, symptoms of collapse, and vomiting. The annexed engraving shows a cutting of the plant, with an enlarged flower (*c*) and vertical section of the seed (*e*).

Fig. 124.



XI. POISONOUS FUNGI.

The fungi constitute a large class of plants, of which some are eaten with impunity, except by a few persons of peculiar constitution; and many more, habitually eaten on the Continent, are now recommended for use in England; while others at least as numerous are esteemed, or known to be, poisonous.

The *symptoms* of poisoning by fungi are very variable in the

* 'Pharmaceutical Journal,' 1862, p. 277.

time at which they appear; sometimes coming on soon after eating them, in other cases, after an interval of some hours, and even as late as twenty-four, or even thirty-six, hours. Nor are the symptoms always developed in the same order, for symptoms of irritation of the alimentary canal sometimes precede the nervous symptoms, sometimes follow them; and in the same group of cases, some will suffer from intestinal irritation, others from nervous symptoms. The symptoms of irritation consist of constriction of the throat, nausea, heat and pain of stomach, painful retchings, and vomiting with or without purging; and the nervous symptoms of headache, giddiness, dimness of sight, illusions of the senses, delirium, and coma. The symptoms caused by most of the poisonous fungi often run a rapid course, without intermission or relief, and death may take place within twenty-four hours. One poisonous fungus (amanita muscaria) appears to produce the pleasing intoxication of the laughing gas, and is in use among the natives of Kamschatka. The urine contains the active principle, and when drunk by others causes the like feeling of intoxication. From this fungus Schmiedeberg has isolated an alkaloid called *muscaria*, which is soluble in water and alcohol, and sparingly in chloroform, but not at all in ether. This alkaloid, when given to cats in poisonous doses (0·002 to 0·004 grams) causes increased flow of tears and saliva, expulsion of excreta, contraction of the pupils, a slow pulse, dyspnœa, and death with slight convulsions. It exerts a special action on the heart, causing it to stop in the state of diastole. This effect is attributed to irritation of the inhibitory apparatus of the heart itself; and this effect is counteracted by atropine.

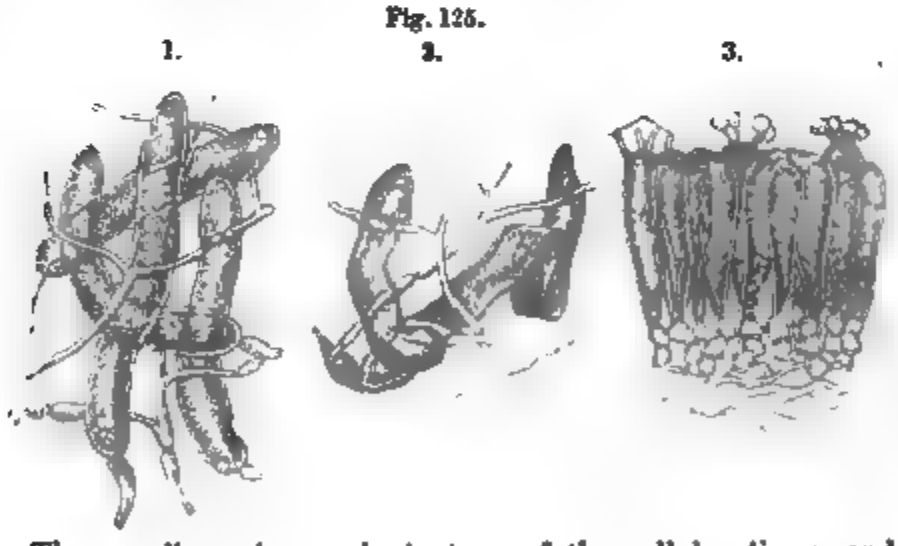
The *post-mortem appearances* consist in inflammation and its consequences in the stomach and bowels, and of congestion of the brain with softening of parts of it.

The *treatment* consists in the prompt use of emetics of common salt, followed by a full dose of castor oil, and the free exhibition of mucilaginous drinks.

Diagnosis.—The distinction of poisonous and esculent fungi is less easy than might be wished. With the exception of the common field mushroom (*agaricus campestris*) and of the puff-ball (*lycoperdon giganteum*) in its early growth, while presenting a compact white texture throughout, there are few, if any, edible fungi which the common people can be trusted to distinguish from poisonous ones. Even when the two kinds are contrasted in charts faithfully drawn and coloured, some care is needed to distinguish one or two of the species from others which resemble them. Nor can the general rules that have been laid down for

the distinction of the one class from the other be depended on. The vulgar test of the silver spoon which is supposed to be discoloured when boiled with poisonous fungi, is quite useless; though it may serve to indicate decomposition, and the formation of sulphuretted hydrogen. The following general precautions may, however, be observed with advantage:—Rejecting, to begin with, all fungi that have an eminently offensive and repulsive odour, and those which present green or scarlet colours of unusual brilliancy, those also should be disallowed which have a bitter, styptic taste, burning and parching the throat; those, too, that have a livid hue, and assume various colours when broken or bruised; those again which rapidly deliquesce, or yield a "spiced milk" of whatever hue, and whether changing colour or not. These rules should be observed by the ignorant, and not be broken without caution by the better informed.* In the cooking of fungi the free use of salt and vinegar is recommended. Some volatile poisonous matters are also dispelled at the boiling temperature. It may be well to add that wholesome fungi have been rejected through prejudice; or in consequence of the occasional production of symptoms of indigestion by stale fungi, or by those which unite a compact texture with the presence of nitrogen. The common mushroom, so largely eaten in England, is rejected in Italy.

Fig. 125.

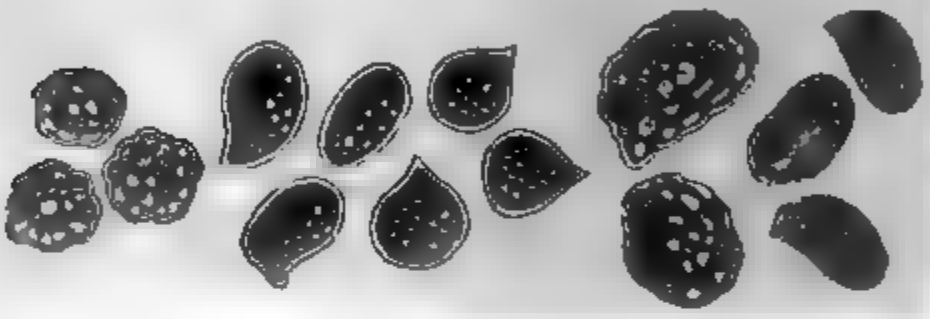


The peculiar microscopic texture of the cellular tissue, and spores of the fungi, whether wholesome or poisonous, may enable

* Reference may be made to the scientific and learned treatises of Berkeley and Badham ('Outlines of British Fungology,' and the 'Esculent Fungi of England'), to the more popular work of M. C. Cook, and the coloured charts, with explanations, by W. G. Smith.

as to ascertain by an examination of the contents of the stomach, or vomited matters, that some fungus has been taken with the food.

Fig. 126.



The annexed illustrations, after larger drawings given by Tardieu, on the authority of M. E. Bondier, show these characteristic structures. Fig. 125, 1, shows the cellular tissue of the *pileus* of the amanita bulbosa; 2, shows the same tissue after cooking; 3, the *hymenium* and sub-hymenial tissue of the same, with the *basidia* surrounded by four *stigmata* bearing spores.

Fig. 126 shows the spores of the Russula emetica, 1; those of the amanita bulbosa, 2; those of the lactarius deliciosus, 3; and the ripe spores of the agaricus campestris, or common mushroom, 4.

CHAPTER XI

INEBRIANTS.

I. ALCOHOL. II. ETHER. III. CHLOROFORM. IV. CHLORAL.

COAL NAPHTHA, BENZOLE, NITRO-BENZOLE, ANILINE, AND CARBOLIC ACID. WOOD NAPHTHA, OIL OF TURPENTINE, KREASOTE, AMYLENE, AND AMYLIC ALCOHOL. NITRO-GLYCERINE. DIPPEL'S OIL.

THE poisons alcohol, ether, and chloroform, have the common property of inducing a state of narcotism, often preceded by delirious excitement, and followed by indisposition, of which nausea and vomiting are generally the leading symptoms. In large doses, and in a concentrated form, they may destroy life suddenly by shock; but they generally prove fatal by inducing a state allied to apoplexy, or by paralysing the heart. They act as irritants to the parts with which they come in contact, producing intense inflammation in the lining membrane of the stomach when swallowed, and in that of the air-passages when inhaled. But they do not affect the whole tract of the intestinal canal, as poisons of the irritant class do.

All the poisons of this group are more or less volatile, and their vapours, when inhaled, act more powerfully than like quantities of the liquids themselves when swallowed. A special importance attaches to ether and chloroform as anæsthetics.

I. ALCOHOL.

Alcohol, or spirit of wine, is the active ingredient of a great variety of intoxicating agents obtained from fermenting saccharine juices. By the distillation of such fluids, followed by rectification with charcoal, and a final distillation with quick-lime, *anhydrous* or *absolute* alcohol is obtained. This, diluted with 16 per cent. of water, constitutes rectified spirit, and with little more than its weight of water, *proof spirit*, which differs little in strength from the various *ardent* spirits distilled from wine, malt, molasses, or rice, flavoured and coloured with burnt sugar, juniper berries, and peat,

and known as brandy, hollands or gin, whisky, rum, and arrack. The absolute alcohol in these ardent spirits varies from 51 to 54 per cent. Of the stronger wines it constitutes from 12 to 17, of the lighter wines from 7 to 9, and of the stronger English malt liquors from 5 to 6 per cent.

Properties.—Pure alcohol is a colourless, volatile liquid of low specific gravity (0·795), boiling at 173°, and not freezing at the lowest attainable temperature. It has a pleasant odour and pungent taste, is very inflammable, burns with a light-blue flame, and yields, as products of combustion, carbonic acid and water.

Tests.—*a*. When burned, it leaves no stain of charcoal. *b*. The products of combustion render lime-water or the solution of nitrate of baryta white and turbid. *c*. It dissolves camphor. *d*. To a drop of alcohol add dilute sulphuric acid, and a drop of a solution of bichromate of potash, and apply the heat of a spirit-lamp. The orange-coloured solution is changed to green by the liberation of oxide of chromium, and the fruity odour of *aldehyd* is perceived at the mouth of the tube.

In Organic Liquids.—The contents of the stomach in persons killed by large doses of spirituous liquors generally have the odour of the spirit. If they contain any spirit it may be separated by distillation. If they have an acid reaction, they must first be neutralized by potash. The liquid resulting from the distillation may be identified by the tests just enumerated applied as follows:—Dip a glass rod into the distilled liquid, and see if it burns. Apply the chrome-test as above. If these tests fail, place the liquid in a tube, and add dry carbonate of potash as long as it dissolves. The water will be taken up by the carbonate of potash, and the alcohol will rise to the surface. Draw this off with the pipette, and repeat the tests.

Alcohol is absorbed, and may be detected by its odour, and by tests applied to the products of distillation in the blood and secretions, in the brain, and in other solid viscera.

Experiments on Animals.—From Sir Benjamin Brodie's experiments on rabbits with large quantities of proof spirit, it appears that symptoms of poisoning set in immediately or in a few minutes, and that death ensues in from half an hour to an hour and a quarter. In one experiment two ounces of proof spirit were injected into the stomach of a rabbit, and the injection was scarcely completed when the animal became perfectly insensible. It appeared dead in twenty-seven minutes, but the heart had not ceased to beat. The symptoms were complete insensibility, dilatation of the pupils, rapid pulse, laborious and stertorous

breathing, and slight convulsions. The lining membrane of the stomach bore marks of acute inflammation.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—After a period varying from a few minutes to an hour or more, according to the quantity and strength of the alcoholic liquid—a period during which there is often an agreeable physical and intellectual excitement—the symptoms set in with confusion of thought, headache, giddiness, imperfect or double vision, indistinct and stammering speech, uncertain and abrupt movements of the limbs, and a tottering and stumbling gait. At length the patient becomes speechless, motionless, and insensible, with a bloated and suffused countenance, injected eye, dilated and fixed pupil, livid lip, and slow stertorous breathing. Recovery may take place after a prolonged sleep attended with profuse perspiration, or more abruptly by vomiting; or death may occur after an interval of several hours with symptoms of collapse, indicated by pallor of the face, cold sweats, quick and feeble pulse, involuntary evacuations, and complete relaxation of the limbs. Very large quantities of ardent spirits kill almost instantaneously by shock. Insensibility either sets in suddenly, or as a relapse after apparent recovery. Convulsions are among the occasional symptoms, and delirium tremens and raging incoherence are sometimes the result of a single debauch.

Diagnosis.—Alcoholic poisoning may simulate concussion of the brain, apoplexy, or poisoning by opium. When a patient is seen in the advanced stages of alcoholic coma, an absolute diagnosis is extremely difficult, and, in some cases, impossible. The smell of drink only indicates that the person has been drinking, not that the symptoms are caused by alcohol; for the patient may have been only drinking moderately, and yet be suffering from cerebral hæmorrhage or narcotic poisoning. The smell of drink would, however, indicate the necessity of resorting to the use of the stomach-pump. Hughlings Jackson relates the case of a person who was supposed to be intoxicated, and was left to sleep it off, but who was really suffering from the effects of cerebral hæmorrhage. As regards the appearance of the face and the state of the pupils, no absolute reliance can be placed on them. Dr. Woodman says that in alcoholic coma the face may be either flushed or pale, and the pupils either contracted or dilated. These facts render it necessary to be very careful in expressing a positive opinion.

Post-mortem Appearances.—The most constant appearance is a deep crimson or dusky red colour of the lining membrane of the stomach, sometimes extending upwards to the gullet and downwards to the commencement of the small intestines. In some cases there is dark extravasation under the lining membrane; in others, there are inflamed patches; in others, again, no marks of inflammation in any part of the organ. Congestion of the brain, and of the air-passages, are less constant appearances. The alcoholic odour is perceptible in the brain.

Treatment.—The stomach-pump should be used without delay, and the cold affusion as a shock. The after-treatment will depend on the patient's state. If there is much congestion of the brain, blood may be drawn from the arm. If great difficulty of breathing, with cold surface and feeble pulse, the treatment proper to apnœa may be required, and in the last resort, galvanism.

Chronic Poisoning by Alcohol.—Drunkards suffer from functional and organic diseases of all the important organs of the economy from indigestion, with vomiting and purging, through irritation of the stomach and bowels; from jaundice, through irritation of the liver; from albuminous urine, diabetes, and other urinary disorders, through irritation of the kidney; from congestion of the brain, delirium tremens, and insanity, paralysis, convulsions, and shaking palsy; as the effect of the poison on the nervous centres. The organic diseases induced by the prolonged abuse of spirituous liquors are degeneration of the liver, kidneys, heart, brain, and spinal cord, scirrhus of the stomach, and pulmonary consumption. Dropsy is a common result of the organic diseases of the drunkard.

II. ETHER.

Several volatile and inflammable liquids are known under the general name of *ether*, and they are divided into the three groups of simple, double, and compound ethers. The liquid known as ether, ordinary, vinic, or sulphuric ether, belongs to the first group, and is the poison here spoken of. It is the product of the distillation of a mixture of alcohol and sulphuric acid.

Properties.—Pure ether is a limpid, colourless liquid, highly volatile and inflammable, with a specific gravity of 0·735°, boiling at 95°, and freezing at about — 24°. It evaporates without residue, burns with a yellow flame, and deposits charcoal on cooled surfaces, but when burned with a proper proportion of oxygen is resolved (like alcohol) into carbonic acid and water. It yields a dense, inflammable vapour, which forms with oxygen or air, in certain proportions, an explosive mixture. Its odour is penetrating

and characteristic, and its taste hot and pungent, but in evaporating it gives a sensation of cold. It is sparingly soluble in water, but freely in alcohol. It is also a powerful solvent of several bodies, among others iodine, corrosive sublimate, and certain of the alkaloids.

Tests.—*a.* Its characteristic odour. *b.* Its imperfect combustion, leaving a stain of carbon on cool surfaces. *c.* Its partial solubility in water, the bulk of the liquid floating on the surface. *d.* It has the same reaction as alcohol with bichromate of potash and sulphuric acid.

In Organic Liquids.—Ether is separable from the contents of the stomach by the same process of distillation as alcohol.

Experiments on Animals.—The experiments of Orfila show that ether produces nearly the same effect on animals as alcohol.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Large doses of liquid ether, such as several drachms, give rise to nearly the same effects as alcohol. A stage of delirious excitement is followed by narcotic symptoms.

The symptoms which follow the inhalation of the vapour show themselves more quickly, and are more severe than those that follow the swallowing of an equal quantity of the poison. The first effects are seen in quickened pulse and respiration, flushed face, suffused eye, and mental excitement; but if the inhalation be continued, the patient falls into a state of stupor, with slow laborious stertorous breathing, and quick pulse. The face and lips are livid, the surface pale and cold, the pupil dilated and fixed, the eye turned upwards, and the whole voluntary muscular system relaxed. If the inhalation is carried on for a few minutes only, these symptoms soon disappear; but if it is continued for ten minutes, a quarter of an hour, or more, all the effects are increased, and the patient is roused with difficulty. When the effect of the poison is complete, sensation is suspended, so that long and difficult operations may be performed either without any evidence of pain, or with indications of suffering which leave no recollection behind them. But the symptoms do not always conform to this description. The poison sometimes causes violent excitement; in other cases, a state of incoherence; in others, again, a troublesome cough; and nausea and vomiting either occur during the inhalation, or they are among the symptoms of recovery. The prolonged inhalation of the vapour may end fatally.

Post-mortem Appearances.—Those due to poisoning by alcohol.

The odour of ether perceptible in the contents of the stomach, and throughout the body.

Treatment.—That of poisoning by alcohol.

III. CHLOROFORM.

Chloroform, or chloroformyl, is one of the large class of chemical compounds formed by substituting chlorine, bromine, or iodine for the hydrogen of the simple or compound ethers. It is obtained by distillation from a mixture of slaked and chlorinated lime, rectified spirit, and water.

Properties.—Chloroform is a colourless liquid, of high refractive power, and high specific gravity (1·497), very volatile, giving off a dense vapour, and boiling at 142° F. It has a sweet pungent taste, and a strong pleasant odour compared to that of apples. It is perfectly soluble in alcohol and ether, but very sparingly so in water, in which it sinks in large globules. If pure it has a neutral reaction, does not discolour oil of vitriol, has no odour of chlorine, and leaves no unpleasant odour on evaporation. It dissolves camphor, volatile oils, wax, resin, caoutchouc, gutta percha; iodine, bromine, sulphur, and phosphorus; and some of the alkaloids, among which strychnia is the most important. At a red heat its vapour is resolved into chlorine and hydrochloric acid.

Tests.—*a.* Its taste and odour. *b.* Its high specific gravity and sparing solubility in water. *c.* It is not easily inflamed, and burns with a green flame. *d.* It completely dissolves camphor, gutta percha, and caoutchouc. *e.* It produces its characteristic effects on small animals.

In Organic Mixtures.—Liquid chloroform may be separated from the contents of the stomach by distillation at 120° F. The vapour may be separated from the blood and tissues by the same process, or by one based on the fact that, when transmitted through a tube heated to redness, it is decomposed and resolved into chlorine, hydrochloric acid, and carbon. The method of procedure is very simple. The organic matter is put into a flask with a narrow tube bent at right angles. On heating the mixture to a temperature of about 150°, the chloroform is volatilized, and on heating the tube with the flame of the spirit-lamp, is decomposed. The vapours that issue from the open end of the tube, if received on paper moistened with solution of iodide of potassium and starch, develope the characteristic blue colour; if received on a glass plate moistened with a solution of nitrate of silver, the chloride of silver is formed; while moistened litmus paper is first reddened and then bleached.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Chloroform whether swallowed or inhaled produces symptoms resembling those caused by ether. In the former case it also causes symptoms of irritant poisoning. The inhalation of the vapour causes at first a condition of stupefaction, and then a kind of delirium characterized by shouting, laughing, singing, and violent struggling. The circulation and respiration are quickened, the face flushed, and the pupils contracted. After this stage of excitement sleep comes on with muscular prostration and anæsthesia, slow pulse and respiration, and pale face. The muscular relaxation then becomes more complete, the anæsthesia more profound, and reflex excitability is abolished. The pulse is slow and irregular, the respiration stertorous, the face livid, and unless the administration is stopped, death ensues. The respiration usually ceases first, while the heart continues to beat a little longer.

Death, however, in many cases occurs quite suddenly at an early stage in the administration, either before or just at the commencement of, a surgical operation. The modes of death from chloroform inhalation have been the subject of much investigation, and still require elucidation.

Experiments on Animals.—On animals chloroform produces effects similar to those in man. Death appears to result from its paralysing effect on the centres of respiration or circulation. Sometimes the heart is first affected, at other times the respiration is the first to cease. Paralysis of the heart seems more apt to occur when the vapour is administered not sufficiently diluted with air. It has been shown by experiments that ether has less tendency to affect the heart than chloroform, and therefore it has been preferred as a safer anæsthetic. Sudden death from chloroform is probably due to reflex stoppage of the heart through the vagi. This may be brought about by irritation of the sensory branches of the fifth, caused by the vapour (Hering), or it may be caused by irritation of sensory nerves when an operation is commenced before reflex excitability is sufficiently reduced or annihilated (Brunton, Richardson).

Post-mortem Appearances.—In many cases the appearances are those of asphyxia. The odour of chloroform is perceptible on opening the body. It is especially observable in the cerebral ventricles. The heart is frequently collapsed and flabby. In cases of sudden death the heart may be found in a state of fatty degeneration. Sometimes bubbles of gas are observed in the blood. Their exact nature is not determined. The post-mortem

appearances are, therefore, neither very definite nor specially characteristic.

Fatal Dose.—The vapour from fifteen drops of chloroform has proved speedily fatal. A drachm of liquid chloroform swallowed by a boy four years old, proved fatal in three hours.* For a minute detail of the symptoms and post-mortem appearances in a case of poisoning by repeated doses of liquid chloroform, amounting in the aggregate to more than five ounces, consult the case of Dr. Glover, as described by Mr. F. J. Gant.† Death took place, in this instance, after 25 hours, in spite of judicious and persevering treatment. Consult also the able chapter on chloroform in the last edition of Druitt's 'Surgeon's Vade Mecum.'

Treatment.—Cold affusion as a shock, followed by the treatment proper to apnœa, the tongue being drawn forward to give more free access of air to the windpipe. Bleeding from the jugular may sometimes be of benefit. Attempts to excite respiration and circulation by galvanism or Faradization have been made, but apparently with little success. In poisoning by liquid chloroform, the treatment should commence with the use of the stomach-pump.

IV. HYDRATE OF CHLORAL.

Within the last few years, hydrate of chloral, introduced by Liebreich as a hypnotic and anæsthetic, has come into extensive use in medicine, and numerous cases of accidental and suicidal poisoning have been reported.

Properties.—Chloral, produced by the action of chlorine on alcohol, forms with water the hydrate of chloral, which is a white crystalline substance, possessing a penetrating odour and a hot burning taste. It is freely soluble in water, alcohol, and ether. Under the influence of alkalies it is decomposed into chloroform and formic acid. When its vapour is passed through a red-hot tube it gives the same products as chloroform.

Symptoms.—When chloral is given in medicinal doses it causes in a few minutes, as a rule, a heaviness, passing into profound sleep, resembling natural sleep. Sometimes, however, it gives rise to great excitement and delirium. In poisonous doses it causes sleep of a more profound character, passing into coma. The respirations fall in number, the pulse becomes weak, rapid, and irregular. There is complete muscular prostration and anæsthesia. The temperature falls, and the extremities become cold. The pupils are at first contracted and then dilated. Death

* Taylor, 'On Poisons,' p. 740. † 'Lancet,' April 23, 1859, p. 415.

takes place from cessation of the respiration, or circulation, or from profound narcosis, or in some cases a short time after taking the drug, from sudden stoppage of the heart.

Experiments on Animals.—Hydrate of chloral produces in animals effects similar to those in man. In toxic doses it causes profound coma and anæsthesia, and leads to death, by paralysis of the circulation and respiration. It lowers the temperature in a remarkable degree.

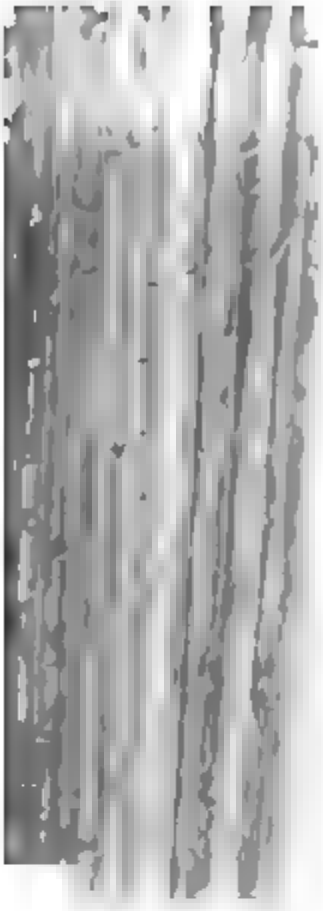
Post-mortem Appearances.—These exhibit nothing characteristic. Uusually there is congestion of the lungs and meninges of the brain. The blood is said by Richardson to coagulate less firmly than usual. The odour of the drug may be perceived in the viscera.

Fatal Dose.—Considerable uncertainty exists as to what may be regarded as a poisonous dose, on account of some unexplained irregularity in the action of the drug. A case is reported by Marshall ('Phil. Med. and Surg. Rep.,' 1871) where 3 grains caused the death of a child a year old in 10 hours. Thirty grains have caused alarming symptoms and death in the case of a woman aged thirty (Fuller, 'Lancet,' March, 1871, p. 226). Reynolds ('Practitioner,' March, 1870) relates a case of nearly fatal poisoning from 45 grains. Watson ('Phil. Med. and Surg. Rep.') gives a case where 80 grains, given in 10-grain doses, over a period of 36 hours, nearly proved fatal. Jolly ('Centralblatt f. die Med. Wissensch.,' 1872, p. 394,) gives two fatal cases of poisoning by 5 grammes (77 grains). Both patients had been in the habit of taking the same dose for several evenings previously, and both died in a few minutes after the last dose. On the other hand, much larger doses have been given without causing serious effects. Anstie ('Practitioner,' 1871, p. 127) relates two cases, one of delirium tremens, where 160 and 180 grains were given; and another of mania, where 120 grains were given with the only effect of inducing prolonged sleep.

For other cases see papers by Richardson ('Med. Times and Gazette,' 1871); Hunt and Watkins ('Brit. Med. Journ.,' Feb. 1871); Norris ('Lancet,' Feb. 1871).

Fatal Period.—From a quarter of an hour to ten hours, or more.

Treatment.—The treatment is much the same as that of opium-poisoning. Means should be adopted of rousing the patient by stimulants, &c. Artificial respiration may be necessary. The subcutaneous injection of strychnia has been recommended as an antidote; but its efficacy has not been fully established.



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ject, a large medicinal dose produces irritation of the stomach and bowels, with giddiness, headache, and drowsiness. Two drachms in a single dose have killed an adult in thirty-six hours.

Fousel or *Fusel* oil (amylic alcohol, potato-spirit, oil of grain).—This liquid, distinguished by its peculiar and disagreeable odour, burning taste, and irritating vapour, acts as an inebriant, whether swallowed or inhaled, causing headache, giddiness, and staggering gait.

Oil of Dippel.—This animal oil is the product of the destructive distillation of hartshorn, bones, and other animal matters. It has twice proved fatal in the human subject, but under circumstances which have prevented a full description being given of the symptoms occasioned by it. Vomiting was present, and, on examination of the body, there were marks of irritation of the stomach and bowels, and of strong corrosive action in the mouth and gullet.

Coal-naphtha.—This result of the distillation of coal-tar has proved fatal to a boy twelve years of age. It was taken in the large dose of three ounces, and death happened in less than three hours. The first symptoms were those of intoxication and furious delirium, soon followed by insensibility, stertorous breathing, and cold skin; then, after partial recovery, following vomiting, fresh symptoms of collapse. Four days after death the body was pervaded by the peculiar odour of the poison.*

Carbolic Acid—Phenol.—The widespread use of carbolic acid in medicine and as a disinfectant has given rise to many cases of accidental and suicidal poisoning from internal administration, as well as to dangerous or fatal results from cutaneous absorption from the sound skin or wounds dressed with carbolic acid lotions.

Properties.—Carbolic acid is met with in commerce in a crude state in the form of a dark liquid of a peculiar odour, and containing a large proportion of xylic and cresylic acids. In the pure state it is in the form of colourless acicular crystals, which fuse at 95°, and readily deliquesce on exposure to the air. It is slightly soluble in water, to which it communicates its characteristic odour, as well as in alcohol, ether, and glycerine.

Tests.—Carbolic acid is recognised by its odour. When concentrated a slip of deal dipped in it, and afterwards in hydrochloric acid, and exposed to the light, becomes of a greenish-blue colour. In dilute solutions perchloride of iron strikes a violet blue colour. A more delicate test is the pale blue colour which is produced when the solution is treated with a quarter of its volume of liquor ammoniæ, and a clot of chloride of lime added. This

* 'Lancet,' 1856, p. 230.

reaction requires a little time, and is hastened by heating. In excessively dilute solutions (1 in 40,000) bromine water in excess causes a yellowish flocculent precipitate of *tribromophenol*, which, on being treated with sodium amalgam, yields oily drops of phenol.

In Organic Mixtures.—These smell strongly of phenol, which can be distilled off on dilution and acidulation with sulphuric acid.

Symptoms.—When the poison is swallowed it causes local caustic effects and a burning sensation in the mouth, fauces, and stomach, followed rapidly by vertigo and a feeling of intoxication. This passes into a state of unconsciousness, stupor, and collapse, with complete muscular prostration and anæsthesia, stertorous respiration, rapid and feeble pulse, and lowering of the temperature. Vomiting is rare, and convulsions are exceptional. Usually there is marked contraction of the pupil. The odour of the poison is perceptible in the secretions of the nose and mouth and in the breath.

Post-mortem Appearances.—The mucous membranes of the mouth, œsophagus, and stomach are pale, corrugated, sodden, and partially detached, and marked by local patches of hyperæmia or capillary hæmorrhage. The marks of the acid may be seen on the lips and chin. There is congestion of the brain and its membranes, congestion and œdema or emphysema of the lungs, and congestion of the abdominal viscera. The heart is sometimes full, at other times empty; or the right side full, and the left empty. The blood is dark and semi-fluid, or only partially coagulated. The organs of the body exhale the odour of the acid. This is particularly evident in the subarachnoid fluid and cerebral ventricles. The urine in the bladder is of a dark or olive-green tint, and has the odour of the acid. The dark colour of the urine is due to oxidation products of carbolic acid.

Fatal Dose.—Dangerous symptoms have been caused by 6 or 7 drops of the acid (Fuller and Pinkham). The exact fatal dose is not determined. Usually the quantity swallowed has been large or indefinite. Half an ounce has caused death in 50 minutes. (Jeffreys and Hainworth, 'Med. Times and Gazette,' 1871, p. 423.) Ogston ('Brit. Med. Journ.,' Feb. 1871) has given a case of death in 13 hours from an ounce to two ounces. Taylor ('Phil. Med. Times,' vol. ii. p. 284) gives a case fatal in from 2 to 3 minutes from a dose of about an ounce.

Death has resulted from cutaneous absorption. An interesting account of such effects is given by Machin ('Brit. Med. Journ.,' Feb. 1868), and by Hoppe Seyler (Pflüger's 'Archiv f. Physiologie,' v. 1872).

Fatal Period.—A few minutes (Taylor), 8 hours (Ferrier), 13 hours (Ogston), sixty hours (Zimm).

Treatment.—The stomach should be emptied by emetics or the stomach-pump. Olive oil has been recommended as an antidote. Huseman states that the most efficient antidote is the *saccharate of lime*, made by dissolving 16 parts of sugar in 40 of water, and adding 5 parts of caustic lime. After three days' digestion the mixture is to be evaporated. It is to be given in water in excess.

Benzole or Benzine.—This is a limpid, colourless liquid, of low specific gravity (0·85), with a peculiar and not unpleasant odour, boiling at 177°, and giving off a highly inflammable vapour. It is not soluble in water, and being an excellent solvent for strychnia, is used to separate it from its solutions. Being also a solvent of fats and oils, it is largely used for removing greasy stains. Both the liquid and its vapour possess poisonous properties.

Nitro-benzole (nitro-benzine, essence of mirbane).—This product of benzole and nitric acid is a thin oily liquid of a pale yellow tint, with a sweet taste, and an odour so nearly resembling that of bitter almonds, that it is often substituted for it in confectionery. It is also largely used under the above title of essence of mirbane, in perfumery. It is distinguished from oil of bitter almonds by strong sulphuric acid, which gives with it no change of colour, but with the oil a fine crimson. It has been shown to be a very active and fatal poison both by experiments on animals, and by several deaths in the human subject, caused by swallowing the liquid, by inhaling the vapour, or by the two combined. Dr. Letheby, in 1863, communicated to the Royal Society a very interesting paper on poisoning by this liquid and by aniline,* from which we learn that both liquid and vapour are most active and energetic, yet insidious poisons. In animals, the poison produced either rapid coma, or paralysis and coma after a long period of inaction. In the human subject, the inhalation of the diluted vapours (as in manufactories of nitro-benzine and aniline) gives rise to headache and drowsiness; but when the vapour is less diluted or the poison is swallowed, there is first drowsiness, then, after a time, flushing of the face, a stupid expression, and an unsteady gait, as if from drinking, followed by increasing drowsiness and then by coma, sudden as in a fit of apoplexy, and continuing till death. From the taking or inhaling of the poison to the coma about four hours elapse, and five hours

* See also the 'Pharmaceutical Journal,' August, 1863. For other cases see 'Centralblatt für die Med. Wissensch.,' 1867, p. 736; 1868, p. 416; and 1872, p. 160.

from that till the death. After death there were flushed face, livid lip, general fulness of the vessels, the blood everywhere black and fluid, the liver of a purple colour. Dr. Letheby concludes that nitro-benzine and aniline are powerful narcotic poisons, exerting little irritant action on the stomach and bowels; sometimes acting and killing quickly, sometimes remaining inactive for a long time; that by oxidation and reduction nitro-benzine is changed in the body into aniline, and aniline (and its salts) into mauve or magenta. This latter change may occur during life on the surface of the body; and it may also take place after death. The characteristic odour and change of colour will greatly assist in identifying the poison as the cause of death. The nitro-benzine is separated by distillation from the organic matters, slightly acidulated with sulphuric acid. For a full description of the method of procedure consult the paper in the 'Pharmaceutical Journal.'

Nitro-glycerine.—This substance, now much used for blasting purposes, is a powerful poison. It causes great headache, giddiness, unconsciousness, general muscular prostration, and occasional convulsions.

It may be observed of all the liquids contained in this chapter, that they possess highly characteristic physical properties, and among them an odour which enables them to be easily recognised in the contents of the alimentary canal and throughout the body

CHAPTER XII.

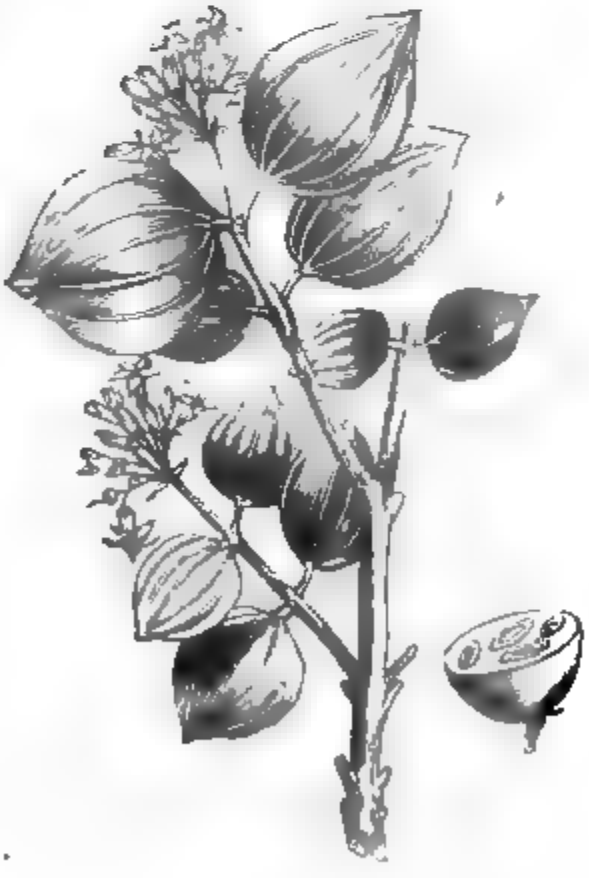
CONVULSIVES.

NUX VOMICA, STRYCHNIA, AND BRUCIA.

THE alkaloid strychnia is the chief active ingredient in several plants that have the common property of giving rise to symptoms similar to those of tetanus. It is generally found with another alkaloid, brucia, possessed of similar, but less active, poisonous properties.

Strychnia is ascertained to be the active poisonous principle of five plants—all natives of hot climates—the Strychnos nux vomica, S. Ignatia, S. tienté, S. toxifera, and S. colubrina. The Strychnos nux vomica grows as a tree in Coromandel, in other parts of India, and in Ceylon; the S. Ignatia in the Philippine Islands, also as a tree; the S. tienté in Java, as a large climbing shrub; the S. toxifera is a native of Guiana; and the S. colubrina grows as a tree in many parts of Asia. A cutting of the S. nux vomica, with a section of the fruit showing the seeds, is given in fig. 127.

Fig. 127.



The S. nux vomica yields the poisonous seed and bark in use in this country; the S. Ignatia produces the seed known as the bean of St. Ignatius, the S. tieuté supplies the bark of which an aqueous extract constitutes the upas poison; the S. toxifera was till lately the reputed source of the poison variously designated as woorara, woorali, corara, curare, and ticunas, used by the natives of South America in preparing their poisoned arrows. There is now reason to believe that this poison is a compound derived from several sources (animal and vegetable).

There are three vegetable productions more or less common in England which contain strychnia—the bean of St Ignatius, and the bark and seeds of the Strychnos nux vomica.

The beans of St. Ignatius are not often met with out of museums. They are the seeds of the pear-shaped fruit of the S. Ignatia, in which they exist to the number of about twenty. They vary in size from that of a nut to that of a large filbert. They have a thin brown outer coat, which is easily detached, and leaves a smooth, black surface. They are very hard, and look like small pebbles with irregular rounded outline, and two or three unequal flattened surfaces. They contain strychnia in the large proportion of 12 parts in 1000, and some brucia, and act like nux vomica or strychnia.

The *bark of the Strychnos nux vomica*, formerly mistaken for cusparia or angostura bark, and named, accordingly, "false Angostura bark," has a very characteristic appearance. It is quilled, or twisted like dried horn, and is thickly covered with white prominent spots bearing some resemblance to a lichen. It yields a light yellow powder of an intensely bitter taste, which is reddened by nitric acid. It contains both strychnia and brucia, and acts in the same manner as the seed of the alkaloid.

The nux vomica, or seed of the S. nux vomica, is much more important, and requires to be more minutely described.

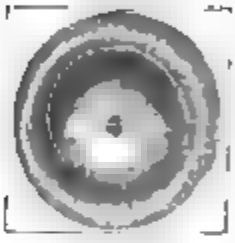
NUX VOMICA.

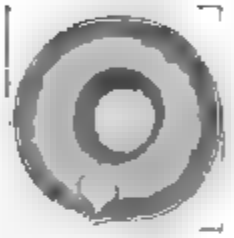
This poisonous seed is largely imported into this country; and a spirituous extract (extractum nucis vomicæ) given in the dose of half a grain to two grains, and a tincture, containing forty-four grains to the ounce (dose ten to twenty minims) are in the British Pharmacopœia. The nut or seed, as well as the alkaloid and its salts, are in common use as poisons for wild animals, rats, and vermin; and they are prescribed as medicines in paralytic affections, and in some other diseases to which they would seem less applicable. In the two years 1837-8, nux vomica was the cause of death in three instances.

The seeds, three to five in number, are enclosed in a rich

orange-coloured fruit of the size and shape of a large apple. They are circular in outline, and vary in thickness, and in size from that of a shilling to that of a florin. Their edges are rounded; one surface is concave, the other convex, or convex in the centre and deeply grooved near the margin as in fig. 128. A horizontal section has the appearance shown in fig. 129, and a vertical sec-

Fig. 128. Fig. 129. Fig. 130.





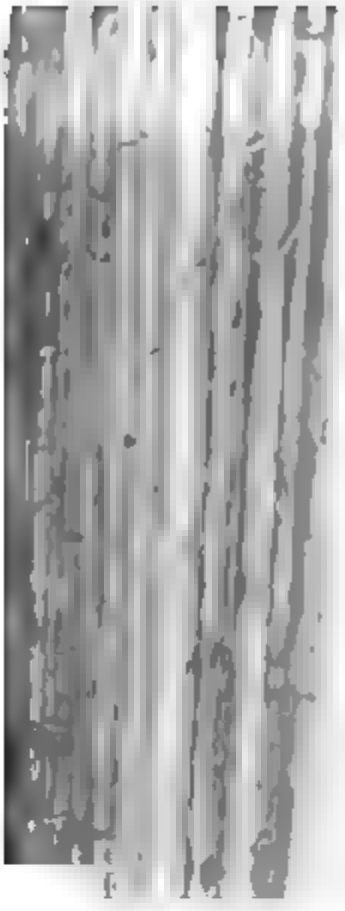
tion displays a circular central cavity and heart-shaped embryo, as in fig. 130. By introducing a sharp knife at the projecting point shown in fig. 128, the seed may be easily cleft so as to display the embryo. The seeds have an external coating of light brown silky hairs, radiating from the centre. They are so hard that they can only be reduced to powder by rasping or filing. When turned in the lathe they yield a white shaving. The interior of the seeds is white or slate-coloured, and of a waxy consistence and gives a rich orange colour with a drop of nitric acid, and a green with the perchloride of iron.

The powder of the seeds has the colour of jalap powder, a faint odour, and an intense and persistent bitter taste. The brown silky fibres which coat the nut are seen in large numbers under the microscope, and are very distinctly defined when treated with a drop of strong nitric acid. The watery solution of the powder is rendered pink by nitric acid, and green by the perchloride of iron. The powder contains the alkaloids strychnia and brucia in union with strychnic or igasuric acid. The quantity of strychnia has been variously estimated at 4 and at 10 parts in the 1000.

The extract is readily recognised by the rich orange colour imparted by nitric acid, the lake colour developed by sulphuric acid, and the transient blue tint given by sulphuric acid and bichromate of potash.

Symptoms.—Those of poisoning by strychnia; combined in some cases with irritation of the alimentary canal.

Commencement of Symptoms.—From five minutes to an hour, or even more, according to the form in which it is given.



Treatment.—The poi
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This alkaloid is largel
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is usual to insert it into t
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powder known as "Batth
to an analysis by Dr. Letl
with flour, sugar, and l
Killer" consists of strych
lower proportion of about
have eaten of poisoned mea
to other animals.

Strychnia in the dose of
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oblique planes. When obtained from solutions of its salts by addition of liquor ammonia, or, still better, by exposure to its vapour, they present under the lens or microscope three leading forms—the long rectangular prism, the short hexagonal prism, or the regular octahedron. From a group of crystals obtained by exposing a drop of a solution of the acetate of strychnia to the vapour of ammonia, the forms shown in figs. 132 and 133 have been selected.* The crystals in fig. 132 are long four-sided prisms, isolated or in stellate groups, with a single octahedron shown in contact with one of the prisms. The crystals in fig. 133 are either regular octahedra or modifications of the same, or short six-sided prisms; and there are one or two dodecahedra, rhomboidal and pentagonal, as well as plates of different

Fig. 131.

Fig. 132.

Fig. 133.

forms, and among them one of the deep triangular plates so common in some specimens of arsenious acid. The octahedra will be recognised in the several points of view in which they present themselves, on referring to the account given of the crystals of arsenious acid at p. 409.

Strychnia has an intensely bitter and very persistent taste, which is stated to be distinctly perceptible in solutions containing one grain of the alkaloid in a gallon (70,000 grains) of water. Strychnia is so insoluble in water as to require for its solution upwards of 7000 times its weight, at 50° (one grain in about fourteen measured ounces), and 2500 times its weight at 212°. Wormley gives, as the result of many experiments, one in 8333 parts of water. But it is more or less soluble in ether, alcohol,

* Acetate of morphia similarly treated yields prismatic forms only (fig. 106, p. 534).

Tests.—*a*. The form
intensely bitter taste.
d. The negative effect
belongs to the group of
by cold sulphuric acid.
acid solution is warmed,
heated. *e*. The chemics
of sublimation.

The Colour Tests.—1
smallest visible crystal
white porcelain, or enam
sulphuric acid, and mix t
glass spatula. No chang
brucia, a faint rose tint.
of bichromate of potash,
agent together with the
placed the porcelain in a f
tact a deep rich blue colou
the reagent into the acid
liquid, which soon change
from crimson to a rich red
a bright red, which colour
in the same manner with tl
ceed in the same way with t
a drop of strong sulphuric
minute fragment

purple of the mulberry; and 3. The bright clear red of the sweet orange. Of these colours, when the reaction is normal, and the colour-developing substance is at once stirred into the acid liquor, the first lasts from half a minute to forty-five seconds, the second colour one, two, or three minutes, and the third for several hours or days. So that it is not of a mere flash of colour that we speak when describing the colour-tests, but of a successive change of colour that can be deliberately watched and readily recognised.

These tests all give highly satisfactory results, but the most delicate is the permanganate of potash.* Sonnenschein recommends the sesquioxide of cerium and sulphuric acid as a test for strychnia of great delicacy. Employed in the same manner as the above tests it causes a beautiful blue, which passes slowly into violet, and finally into a cherry-red, which lasts a long time ('Archiv der Pharmacie,' cxciii. 252).

The colour tests are equally applicable to crystalline spots obtained by evaporating solutions of the alkaloid, or of its salts; and they react with the greatest delicacy and certainty on the sublimates presently to be described.

2. Galvanic Colour Test.—This also is applicable to a crystal or granule of strychnia, or to a deposit of the alkaloid from its solutions. Place a drop of a solution of strychnia (say one part of the alkaloid in 10,000, or even 20,000, of water) into a cup-shaped depression in a piece of platinum foil, and allow it to evaporate. When dry, moisten the spot with a drop of concentrated sulphuric acid. Connect the foil with the positive pole of a single cell of Grove's or Smee's battery, and then touch the acid with the platinum terminal of the negative pole. In an instant the violet colour will flash out, and on removing the pole from the acid the tint will remain. (Letheby.)

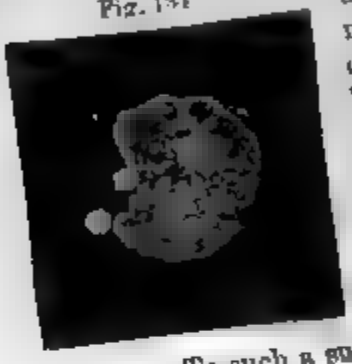
The Test of Sublimation.—This test also is one of extreme delicacy, succeeding best with such minute quantities as the $\frac{1}{100}$th down to the $\frac{1}{10000}$ of a grain. The larger quantity will yield fifteen or more successive sublimates; the smaller, at least one distinct sublimate. The coarser sublimates from the larger quantity will also yield characteristic secondary sublimates. Like the colour tests, this is applicable to the alkaloid as deposited from its solutions.

The mode of procedure is that described and figured at p. 405, Fig. 50. A fragment of crystal, or a speck of powder, is placed on a

* For a careful examination of the colour-tests for strychnia, and reasons for preferring the solid to the liquid form of the soluble reagents, see a paper by Dr. Guy in the 'Pharmaceutical Journal,' 1861. See also the same Journal, July, 1856, for an instructive paper by Mr. W. Copney.

clean dry crucible cover, in the centre of a ring of glass. A glass disk, or microscopic slide, is dried and heated in the flame of the spirit-lamp, and placed on the ring. The flame is then applied to the porcelain till its temperature is considerably raised; when a mist will appear on the glass disk, and upon this, one by one, several milk-white circular spots, remaining distinct, or coalescing, are seen to form. These are often crystalline, as seen by the naked eye, and in good specimens have the appearance shown in fig. 134. Similar appearances occur (though less uniformly) in the sublimates of morphia, and they afford a strong presumption of the presence of strychnia. To such a sublimate as is here shown, and, indeed, to sublimates that are much less characteristic, the colour tests as well as all the liquid tests which give good results with strychnia, or its solutions, may be applied with confidence. The parts of the sublimate which are least characteristic should be chosen, and to these the several reagents should be applied in succession under the microscope, the more characteristic crystalline appearances remaining intact.

Fig. 134.

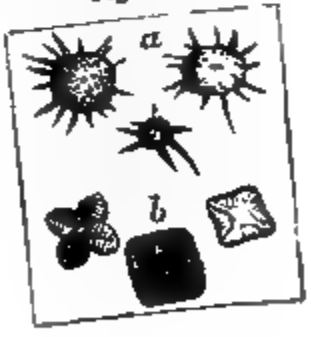


When this sublimation is conducted after the manner described at p. 407, strychnia is found to remain unchanged up to a temperature of about 345°, when it will begin to yield sublimates. At 430° it melts, and continues to yield sublimates till exhausted, and reduced to a carbonaceous film.

The sublimates, examined under the microscope, assume many forms. They may consist of drops, or waving patterns, coloured or discoloured, as if smoked; but the greater number are more or less crystalline.

Fig. 135.

Fig. 136.



Crusts obtained at high temperatures, with the glass c

ably heated, consist of characteristic isolated crystals, such as are obtained from liquid solutions (fig. 135), or they may contain such crystalline forms as are depicted at *a* and *b*, fig. 136.

An amorphous centre, with penniform or lattice-shaped border is not uncommon, and it may be stated generally that while the sublimates of morphia (fig. 107, p. 525) are made up of curved lines, those of strychnia consist (as in fig 137) of lines either straight or slightly curved, with parallel feathery lines at right angles.

Fig. 137.

In the coarser crusts, the dark spots, or feathered crystals, mentioned as occurring in the sublimates of morphia (p. 526), are often to be seen lying on the slide, or projecting from it. They present such forms as are shown in fig. 138.

The sublimates of strychnia, then, assume so many forms* that they are not in themselves conclusive of its presence; but it fortunately happens that there is no form that does not give with certain liquid reagents results which prove the existence of strychnia beyond the reach of doubt.

Fig. 138.

In the first place, as already stated, the colour tests act on the sublimate with extreme delicacy; so that to a small spot consisting of the $\frac{1}{10000}$ of a grain all these tests may be applied with ease and certainty, minimum drops of sulphuric acid being used, and the smallest visible speck of the colour-producing substance.

A second reaction of like delicacy is obtained by touching some portion of the sublimate which happens to present the least characteristic appearance with a minimum drop of an aqueous solution of carbazotic acid ($\frac{1}{250}$). Immediately, or in a few seconds or minutes, small round greenish brown spots show themselves, which spread and often coalesce, and become the

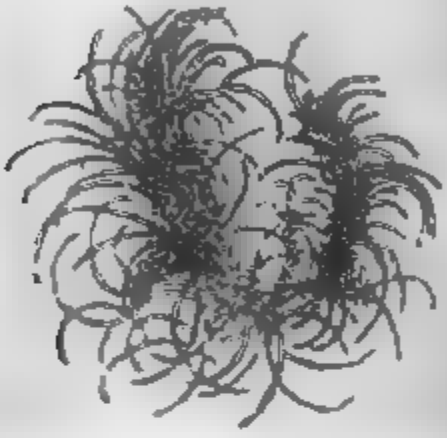
Fig. 139.

Fig. 140.

* See these forms described and illustrated in a paper read by me (G.) at a meeting of the Royal Microscopical Society, Oct. 1867, and published in its Journal.

centres of delicate arborescent crystalline groups, such as are shown in different degrees of delicacy in figs. 139, 140, and 141.

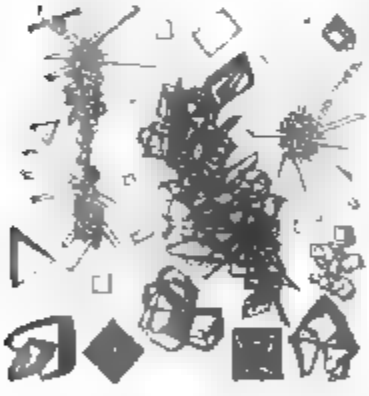
Fig. 141



It will be observed that the elementary form in all these figures is a book or claw, or large section of a small circle. This is a rare form, and an eminently characteristic reaction; and it is one which I propose with confidence as a test for strychnia both delicate and safe, and *probably* peculiar to this alkaloid. If not peculiar, it is certain to be shared with very few other substances.

A third reaction, which is both delicate and of uniform occurrence, is that with the bichromate of potash. An aqueous solution of this substance (which, when dry, displays the delicate arborescent form depicted in fig. 102, p. 519) often instantaneously, always speedily, develops isolated yellow plates, generally square or oblong, or groups such as are shown in fig. 142.

Fig. 142.



This reaction, too, is either peculiar to strychnia, or likely to be shared with very few other substances.*

These statements, though made with caution and reserve, are nevertheless founded on experiments (in some instances often repeated) on a large number of alkaloids and analogous active principles. But it should be borne in mind that the sublimates of the alkaloids must needs resemble those of the inorganic poisons as well as crystals deposited from solutions, in being subject to great variety of form, as well as to success and failure. It should also be understood that the evidence of the presence of poisons is always cumulative, and that objections may be made to almost every reaction if taken by itself.

* See for many minute details on this subject five successive papers in the 'Pharmaceutical Journal,' from June to October, 1867. (G.)

In the case of this test of sublimation, the evidence would be of this kind. A speck of a white powder or crystal believed to be strychnia, or a minute deposit from a solution in chloroform or benzole, or from a solution of a salt of strychnia neutralized by the vapours of ammonia, is sublimed in the manner described at p. 407. The temperature of the thermometer rises gradually beyond 200°, 212°, 240°, and 280°, at which corrosive sublimate, cantharidine, calomel, and arsenious acid, respectively sublime; and beyond the melting point of the other poisonous alkaloids, till at or about 345° it yields a sublimate or sublimates, melts at 430° and still yields sublimates till at length it is exhausted and reduced to a charcoal spot. Now all the alkaloids, and analogous active principles, liquefy and sublime, and leave a deposit of carbon; but no other among the poisonous alkaloids answers in any degree to the description now given except morphia. But this substance under experiment yields the white spotted sublimate described, and depicted in fig. 134, and in this again, corresponds with either strychnia or morphia; and, when examined by the microscope, shows the crystalline forms that belong rather to the former than to the latter. If now we submit the sublimate to the colour tests for strychnia, it displays the typical succession of colours: and if the slightest doubt or misgiving could remain, there would still be in reserve the remarkable, and probably quite characteristic, reactions with carbazotic acid and bichromate of potash.

2. *In Solution.*

The process for extracting strychnia from organic mixtures presents the poison not as an aqueous solution, but dissolved in ether, benzole, or chloroform. The strychnia so held in solution is allowed to deposit itself on a glass disk or slide, examined by the microscope, and then submitted to the action of the various tests. If one or more of these deposits be treated with dilute acetic acid, a soluble acetate of strychnia is formed to which the liquid tests may be applied. Assuming this procedure to be adopted, the form of the deposits from the solutions of strychnia in ether, benzole, and chloroform will first be described, and then the effect of certain chemical tests on the solution.

Strychnia in ether, benzole, and chloroform.—a. In ether. This crystalline deposit usually assumes dendritic forms; but it may contain octahedra and four-sided prisms. *b. In benzole.* The solution of strychnia in benzole sometimes leaves on evaporation crystals of great brilliancy, distinctness, and permanence. The short six-sided prism is the prevailing form; but triangular

and other plates of various thickness, and dodecahedra, rhomboidal and pentagonal, are occasionally met with, as in fig. 139, p. 573. Generally, however, the deposit, though crystalline, does not present distinct crystals, even when the strychnia and benzole are apparently pure. *c. In chloroform.* The alkaloid is deposited from this solution as rosettes, veined leaves, stellate dotted needles, circles with broken radii, and branched and reticulated forms of great delicacy and beauty. Solutions of strychnia in alcohol deposit forms similar to those yielded by the ethereal solution. (Fig. 143.)

Fig. 143.

Other Chemical Tests.—Several chemical reagents have been recommended as tests for strychnia; of which some, as the solution of iodine and iodide of potassium and tannic acid, are tests for the alkaloids as a class, others sufficiently characteristic to deserve special notice.

Fig. 144.

1. The acetate of strychnia itself, to a weak solution of which the tests are supposed to be applied, crystallizes in tufts of needles (fig. 144).

2. *Carbazotic acid*, a solution of which of the strength of $\frac{1}{250}$ has been already described as a delicate and characteristic test of the strychnia-sublimate, is equally applicable to the solutions of its salts. A drop of this reagent added to a drop of the solution first occasions an abundant gelatinous deposit, which gradually gives place to curved crystals waving in the liquid, like tufts of grass, and presenting when dried the curved, and often delicately feathered forms of fig. 145.

Fig. 145.

3. A solution of *corrosive sublimate* causes an abundant white precipitate, which assumes the highly characteristic crystalline form depicted in fig. 146.

Of other reagents it may be observed that there is no alkaloid

which yields so many well-marked reactions with the many tests that have at different times been recommended.*

Fig. 146.

As the tests for strychnia are also tests for the alkaloids and analogous active principles, it may be well to state what these tests are. Those usually named as indicating the presence of an alkaloid by throwing down a precipitate from its solution, are—tannic acid, the iodo-iodide and iodo-hydrargyrate of potassium, and the phospho-molybdate and nitro-prusside of sodium. The sulphocyanide, chromate and bichromate, ferrocyanide and ferricyanide of potassium; the chloride of mercury (corrosive sublimate), the terchloride of gold, and the bichloride of platinum, with the sesquichloride of iron; also bromine in bromohydric acid, are largely used by those who endeavour to distinguish the alkaloids, and their analogues, the glucosides, by liquid reactions.

With solutions of the salts of strychnia these reagents, without exception, yield distinct precipitates, most of which assume, either instantaneously or speedily, crystalline forms. Sometimes the crystals show themselves as the first effect of the contact of the two liquids; but sometimes they are developed out of flocculent or gelatinous masses.

All these reactions of strychnia, as of the other alkaloids, may be studied with advantage in single drops of their solutions placed on glass slides or disks, and touched with smaller drops of the reagents:—a simple and delicate method which ought to supersede the coarser procedure of the test-tube; and which has the obvious advantage over it, of presenting every change of form and colour in a state suitable for microscopic examination.

In applying the foregoing tests it should be borne in mind that the crystalline forms described or depicted are not uniform in their occurrence; and that differences in temperature, in the strength of the solution of strychnia, and in the strength and purity of the reagents, as well as in the quantity of the reagent left unexpended, give rise to modifications in the forms of the crystals.†

The Physiological Test.—This name has been given to a test first proposed by the late Dr. Marshall Hall, who directed that

* Refer to papers by Dr. Letheby in 'Lancet,' June 28 and July 12, 1856, and to Wormley's 'Micro-Chemistry of Poisons.'

† It may be worthy of note, as bearing on this subject, that the depth of a drop of liquid may determine the form of the crystals deposited by it.

frogs recently taken from a pond should be chosen; that the skin should be dried with blotting-paper; and that the liquid to be tested, being a strong solution of a salt of strychnia, should be dropped on the back. In a short time the frog thus treated became affected with tetanoid or epileptoid spasm, or convulsions. He found that this test could detect as small a quantity as the $\frac{1}{5000}$th grain of the poison; and he thought that if inserted under the skin, or injected into the stomach, a still less quantity might be detected. The delicacy and certainty of this test have been fully confirmed by Dr. John Traill,* Dr. George Harley, Dr. Wormley, and others. Dr. Wormley† gives an account of some experiments on a small species of frog (the Rana halecina), from which it appears that when a solution of strychnia was introduced into the stomach, quantities of strychnia much less than $\frac{1}{5000}$th grain produced characteristic effects.

The experiment is best performed in a Powell's flat specimen glass. The belly of the frog being towards the flat surface: the opening is closed with a cork perforated to allow the passage of a pipette and glass rod. The skin of the frog should be dried before it is introduced into the vessel. Apply a drop or two of a solution of one of the salts of strychnia, or a solution in alcohol of the alkaloid itself, by the point of the pipette to the skin of the back. In a period of time varying from one or two minutes to a quarter of an hour or more, the characteristic tetanic convulsions will show themselves, and will recur every time the glass is shaken, or the frog touched with the glass rod. In many cases the frog utters a shriek or cry expressive of pain. When the dose is large, the symptoms show themselves almost immediately, and death takes place in a few minutes. When the dose is smaller, the symptoms come on after an interval of a quarter of an hour or half an hour, and the animal may recover. The characteristic symptom is generally ushered in by a state of evident distress, with panting respiration and protruding eye.

3. *In Organic Substances.*

The process best adapted to the detection of strychnia in the contents of the stomach, or in the animal fluids and tissues, is that originally recommended by Stas, but since modified by the substitution of hydrochloric acid for tartaric acid, and of chloroform or benzole for ether. The organic matters are first digested with about a tenth part of their bulk of hydrochloric acid over a water-bath, till they are reduced to a fluid state. This

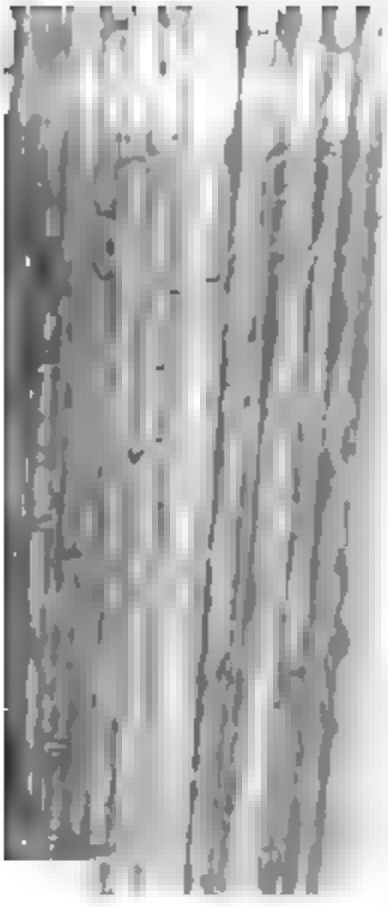
* 'Lancet,' July 12, 1856.
† 'Chemical News,' April 28, 1860.

liquid is then filtered, and the substance remaining on the filter washed with distilled water so long as it has an acid reaction, the washings being added to the filtrate. The liquid is then to be somewhat concentrated by evaporation, and carbonate of soda is to be added in slight excess. The liquid is now to be strongly shaken for several minutes in a bottle or long tube with about half an ounce of chloroform (Messrs. Rodgers and Girdwood) or with benzole (Professor Bloxam). The chloroform having been allowed to subside, or the benzole to collect on the surface, is drawn off by a pipette, transferred to an evaporating basin, and expelled over a water-bath. If the residue left in the basin is free from colour, it may be at once tested for strychnia; but if not, it must be moistened with concentrated sulphuric acid, and exposed for some hours to the temperature of a water-bath, by which procedure all organic matter except the strychnia is destroyed. The charred mass is then treated with water, and the solution filtered to separate the carbon. Ammonia is added to excess, and the solution again shaken with about a drachm of chloroform. If on evaporating a small portion of this chloroform solution, and acting on the residue with strong sulphuric acid, any charring takes place, the same process must be repeated. The chloroform solution ultimately obtained affords strychnia sufficiently pure for the application of the tests. The colour tests may be applied to the deposit left on the porcelain slab after evaporation; the deposit on glass may be examined under the microscope; a solution of the deposited matter in dilute acetic acid may be examined by the several tests just described; and if the deposit is at all considerable (say the thousandth of a grain) it may be sublimed. By this process very satisfactory results are obtained.*

In a medico-legal case examined by Professor Bloxam, he substituted benzole for chloroform, and obtained beautiful crystalline forms similar to those described at p. 579 as characterizing the deposit from a solution of strychnia in benzole. Benzole, though a less perfect solvent than chloroform, has the twofold advantage of being lighter than water, and leaving a crystalline deposit of a more marked character.

Strychnia has now been detected in the contents of the alimentary canal, in the muscles and viscera, and in the blood and urine. Gay ('Centralblatt f. die Med. Wissensch.,' 1867, p. 49) has been able to detect it in the pons Varolii, medulla oblongata,

* See the particulars of an analysis by Dr. Letheby, in a case of poisoning by strychnia, in the 'Chemical News,' September 29, 1860, and 'Br. Med. Journal,' August 4, 1860, in which a similar process was adopted.



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the animal recover.
well shown in the foll
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lapse of fifteen minutes
was tremulous, and m
trembled violently, or st
ings occurred in the lim
noise was made. Afte
gently lifted by the ears
with a violent convulsive
rigidly stretched out

on both sides; the blood in all other parts of the body was liquid, and dark coloured.*

Nearly all animals are affected by strychnia in a similar manner. Some birds, and particularly hens, are less susceptible to its action; and a species of sloth (Cholœpus Hoffmannii) seems to be little affected by it (Peters, in Reichert and Du Bois-Reymond's 'Archiv,' 1868, p. 755). It is said that some monkeys enjoy immunity from the poisonous effects of strychnia.

Frogs, as has been stated, are very sensitive to the action of strychnia; hence they are commonly used as delicate physiological reagents.

Strychnia specially affects the spinal cord, the reflex excitability of which it enormously increases. To this is to be attributed the excitation of the tetanic spasms on the slightest sensory impression. It also seems to stimulate the vaso-motor centre, causing contraction of the vessels and increased blood pressure. Death is the result either of asphyxia from the fixation of the muscles of the chest and interference with respiration, or of the exhaustion of the nerve centres from excessive activity.

Drs. Crum Brown and Fraser have shown that the action of strychnia is entirely altered when it is converted into ethyl and methyl substitution compounds. These cause general muscular paralysis by specifically acting on the ends of the motor nerves, and produce exactly the same effect as curara.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—In a few minutes to an hour or more after swallowing a substance which, if in solution, would have a hot and intensely bitter taste, the symptoms of poisoning set in with a feeling of suffocation and complaint of want of air. These feelings are soon followed by twitchings of the muscles, with cramps and jerking movements of the head and limbs, which shortly become heightened into tetanic convulsions. The arms are flexed and tightly drawn across the chest, the legs forcibly extended and widely separated, and the feet often turned either inwards or outwards, the head bent back, and the whole body arched so as to rest on the head and heels (*opisthotonos*). The muscles of the abdomen are rigidly contracted, respiration is suspended, the pulse is very rapid, the face is livid and congested, the pupil (in the fit) is usually dilated, the eyes prominent and staring, and the features

* For an account of this experiment on animals, and a collection of several cases in the human subject, with an examination of the case of Palmer, see Dr. Taylor's Essay, reprinted from the 'Guy's Hospital Reports.'

drawn into a grin (the *risus sardonicus*). The patient complains of a choking sensation, and of thirst and dryness of the throat but the effort to drink often occasions rigid spasms of the muscles of the jaw. Sometimes there is foaming at the mouth, and the froth may be tinged with blood. After the spasms have lasted for one or two minutes there is a short remission, and the patient lies exhausted, and bathed in sweat, and able to converse and swallow; for the jaw is not always fixed, even in the fit. The fits sometimes return without apparent cause, but they may be brought on by the slightest touch, or the least effort. The mind is generally unaffected till towards the fatal termination, and may even continue clear to the last. The patient is generally quite conscious of his danger, and aware of the approach of the fits, which he announces by screams or shrieks, or by calling out that "they are coming;" and he often asks to be held, moved, or turned over. Towards the fatal termination, the fits become more frequent and severe, and the patient dies exhausted, or suffocated, in most cases within two hours of the commencement of the symptoms. If a patient survive that period there would be fair hope, but no certainty, of recovery.

The *post-mortem appearances* are not highly characteristic, nor are they uniform. As a general rule, the body would seem to be relaxed at the time of death; but it stiffens soon afterwards and remains rigid for a long time. The hands are usually clenched, and the feet arched, or turned inwards. In some cases the body retains the posture of the last fatal spasm. There is usually some lividity about the face, trunk, and limbs. The expression of the countenance is sometimes quite natural. The internal appearances consist in congestion of the brain and spinal cord, of the lungs and air-passages, and sometimes of the mucous membrane of the stomach. In some cases the heart is contracted, and all its cavities empty; in others the right side is full of blood. The blood throughout the body is black and fluid. The urinary bladder is empty.

The *treatment* consists in the prompt evacuation of the stomach by emetics or (if practicable) the stomach-pump, and then in the administration of chloroform, as liquid or by inhalation, for the relief of the pain and to allay the spasms. Tannic acid, strong green tea as containing tannin, and solution of iodine in iodide of potassium, have been recommended as precipitating the poison, and animal charcoal as absorbing it. Chloral hydrate has been employed with apparent success as an antidote, and may be useful. The extract of Calabar bean has some claim to be regarded as a successful physiological antidote. Nicotine, conia, and curara,

also been suggested, but their efficacy requires to be more erified. In regard to curara, it may be said that it can ucceed in preventing the tetanic spasms by paralysing the es. Hence the effect would be a double poisoning instead antidotal action. Combined with artificial respiration, er, the treatment with curara has much to recommend it. ial respiration alone has been found efficacious in animals ube and Rosenthal. The bromide of potassium has been mended as allaying reflex excitability.

mencement of Symptoms.—From five minutes to an hour re. In one case, three minutes; in another two hours and *

al Period.—Shortest, ten minutes; longest, six hours.

al Dose.—A quarter of a grain of strychnia may destroy out patients have survived doses of twenty grains or more.

gnosis.—It will be seen that the symptoms of poisoning by nia are closely allied to those of the disease known as s or locked-jaw. In poisoning by strychnia, as in tetanus, are violent paroxysms of rigid convulsion, with intense ng; and in both the mind is little if at all affected; and it does suffer, it is apparently as the result of the exquisite e the patient has undergone.

e differences between the disease, tetanus, and poisoning by nia, are well marked. In this country, and in temperate es, tetanus is rare, except as the consequence of a wound or mechanical injury. In tetanus the symptoms are at first e, and develope themselves gradually: in poisoning by nia they are strongly marked at the onset, and attain their evelopment in a few minutes. Tetanus begins with diffi- of swallowing, and stiffness of the jaws and neck, the , legs, and arms being attacked in succession. In poisoning ychnia, all, or nearly all, the voluntary muscles are attacked e same time; and the muscles of the jaw are not only fected first, but sometimes wholly escape, or are violently cted only during efforts to swallow. In tetanus, opistho- does not occur till after some hours or days: in poisoning rychnia, it is among the early symptoms. In tetanus, the oms undergo abatement, but there is no perfect inter- n: in poisoning by strychnia, there are intervals of com- intermission. In tetanus the patient dies after the lapse eral hours or days, or recovers slowly after several days eks: in poisoning by strychnia death happens in from less a quarter of an hour to less than three hours after the

* Wormley, 'Micro-Chemistry of Poisons,' p. 538.

first appearance of the symptoms (death after such a period as six hours being very rare), or the patient recovers in a few hours. Tetanus brought on by direct injury to the nervous centres sometimes destroys life in a few hours.

The tetanus occasioned by strychnia is distinguished from that which occurs in the course of poisoning by other substances, irritant or narcotic, inasmuch as in the former case it constitutes the one symptom, while in the latter it occurs after other symptoms of poisoning have shown themselves; or it is mixed up with them. To this rule, however, it is possible that the salts of morphia, in certain cases, may form an exception. (See p. 535.)

The tetanic convulsions of hysteric and epileptic seizures are similarly distinguished from the tetanus of strychnia-poisoning by forming only a part of the fit. These seizures, moreover, are not in themselves fatal. Death from hysteria is unknown, and it very rarely follows immediately or speedily on an epileptic seizure. There is a marked difference, also, in the character of the convulsive movements. Strychnia produces a rigid tremor, uniformly continuous throughout the paroxysm; whereas in epileptic, epileptiform, or hysteric convulsions, the muscles are alternately relaxed and contracted. In a word, the tetanic paroxysm is distinguished by uniform *rigid tremor*, the epileptic or hysteric fit by *jactitation*.

BRUCIA.

This alkaloid derives its importance from being associated with strychnia in the seed and bark of nux vomica, and in St. Ignatius' bean. It has the same poisonous properties as strychnia, but in a less degree, variously estimated at a sixth or a twelfth.

Properties.—Brucia is usually found as a white powder; but it is readily crystallised in needles or four-sided prisms. When thrown down by ammonia from a solution of the acetate it presents itself in long crossed needles, or in tufts, as in fig. 147. Both forms are obtained from the same solution by the same reagent at the same time; the needles from a drop spread over the disk, the tuft from a deep undisturbed drop.

Fig. 147.

Brucia belongs to the group of poisons which is not changed in colour by cold sulphuric acid; and

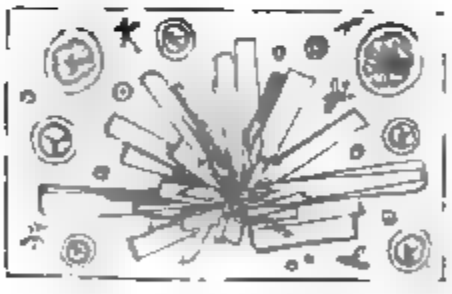
like strychnia, it undergoes no change when the acid solution is warmed, but when heated, it assumes a deeper tint of yellow than strychnia. It is at once distinguished from strychnia by the intense red colour which it strikes with nitric acid—a colour toned down to a faint rose tint when the brucia or the nitric acid is present in very small quantity.

Brucia, when heated on white porcelain, melts easily into a pale liquid, darkens, yields a dense vapour, and swells into a moderately abundant carbon. It gives an odour as of burnt horn. When treated in the manner described at p. 407, it melts at 240° Fahr., and sublimes at 400°. The sublimates are rarely crystalline, and are not characteristic. A solution of carbazotic acid ($\frac{1}{150}$) developes in the sublimates root-like forms. It is more soluble in water than strychnia, slightly soluble in ether, very soluble in alcohol, chloroform, and benzole. Its aqueous solution has an intensely bitter taste. With acids it forms salts.

Tests.—*a*. Nitric acid, as just stated, imparts to brucia and its salts a rich red colour. This red solution, if warmed and allowed to cool, is changed to purple by protochloride of tin, and bleached by an excess of the solution. *b*. Sulphuric acid, followed by bichromate of potash, developes a red or reddish-brown colour, passing to green and yellow.

In the quickness and beauty of its reactions with liquid tests brucia is second only to strychnia. Fig. 148 shows a group of crystals under a low power of the microscope from an acid solution of brucia with a solution of corrosive sublimate ($\frac{1}{100}$). Results of rare beauty are obtained with red prussiate of potash ($\frac{1}{150}$).

Fig. 148.



...symptom, whi...
of poisoning have ...
To this rule, howe...
certain cases, may ...

The tetanic con...
similarly distinguis...
by forming only a p...
not in themselves fa...
very rarely follows i...
There is a marked d...
sive movements. St...
continuous through...
leptiform, or hysteri...
relaxed and contrac...
distinguished by unif...
fit by *jactitation*.

This alkaloid derive...
strychnia in the seed a...
bean. It has the sa...
in a less degree, variou...
Properties.—Brucia...

Fig. 147.

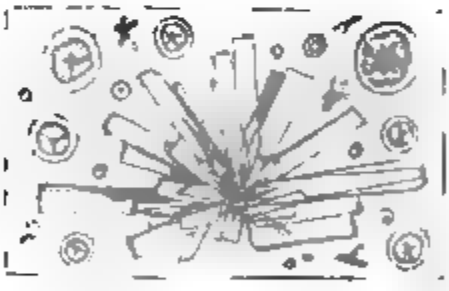
like strychnia, it undergoes no change when the acid solution is warmed, but when heated, it assumes a deeper tint of yellow than strychnia. It is at once distinguished from strychnia by the intense red colour which it strikes with nitric acid—a colour toned down to a faint rose tint when the brucia or the nitric acid is present in very small quantity.

Brucia, when heated on white porcelain, melts easily into a pale liquid, darkens, yields a dense vapour, and swells into a moderately abundant carbon. It gives an odour as of burnt horn. When treated in the manner described at p. 407, it melts at 240° Fahr., and sublimes at 400°. The sublimates are rarely crystalline, and are not characteristic. A solution of carbazotic acid ($\frac{1}{250}$) developes in the sublimates root-like forms. It is more soluble in water than strychnia, slightly soluble in ether, very soluble in alcohol, chloroform, and benzole. Its aqueous solution has an intensely bitter taste. With acids it forms salts.

Tests.—*a.* Nitric acid, as just stated, imparts to brucia and its salts a rich red colour. This red solution, if warmed and allowed to cool, is changed to purple by protochloride of tin, and bleached by an excess of the solution. *b.* Sulphuric acid, followed by bichromate of potash, developes a red or reddish-brown colour, passing to green and yellow.

In the quickness and beauty of its reactions with liquid tests brucia is second only to strychnia. Fig. 148 shows a group of crystals under a low power of the microscope from an acid solution of brucia with a solution of corrosive sublimate ($\frac{1}{100}$). Results of rare beauty are obtained with red prussiate of potash ($\frac{1}{250}$).

Fig. 148.



discussion.) The intelligence is generally unaffected, but d
and coma are occasional symptoms. The effect of conium is
illustrated by the case of Gow, reported by Dr. Bennett ('
Med. and Surg. Jour.,' 1845) After eating hemlock
mistake for "greens" the patient died in a few hours with
toms of universal paralysis, which began in the extremit
extended upwards, gradually affecting the whole muscular
so that loss of voice and of the power of articulation were
before death. Convulsive movements occurred late.
and intelligence continued unaffected till death was at hand.
John Harley gives a very lucid description of the symptom
duced in his own person by five drachms and a half of the
Three-quarters of an hour after taking it he first found th
had lost the power of quick adjustment in the muscles of the
In another quarter of an hour this symptom had much in
and a general muscular lethargy, with heavy eyelid and
pupil, supervened. In another quarter of an hour there
squeamishness and faintness, and he was cold, pale, and totter
The nausea passed off, but the muscular weakness incre
The mind was quite intact, and the pulse, after the first ex
ment, was sixty-eight, and regular. There was "a direct di
nution of power in all the voluntary muscles, almost amount
to paralysis," and "the greatest exertion was at one t
required to elevate the eyelids." In $3\frac{3}{4}$ hours all the sympt
of poisoning had passed off. Similar symptoms occurred in t
young women who took three and four drachms respectively
the succus.*

Post-mortem Appearances.—Those of apnœa, with redne
the mucous membrane of the stomach, and congestion of
vessels of the brain.

Treatment.—After emptying the stomach by emetics, a
dose of castor oil to remove the poison from the bowels; follo
by the treatment proper to apnœa, including the free us
diffusible stimulants.

Commencement of Symptoms.—From a few minutes to
quarter of an hour or more.

Fatal Period.—From one hour to four hours, or more.

Fatal Dose.—The smallest dose of hemlock or its preparation
not ascertained; but Burman, as the result of experiments on hi
self and others, concludes that one ounce of the succus is equiva
to one minim of conia. From experiments on animals, it appe

* See also a series of interesting experiments on the effects of Conh
by Dr. Burman in the West Riding Lunatic Asylum Med. Reports. Vol.
p. 1.

that a single drop of the alkaloid will kill a cat in three minutes, and five drops a dog in one minute.

CONIA (*Conein, conicin, conicina*).

Experiments on Animals.—Experiments on animals have been made with *Conia*, the properties of which are given below. Conia acts on all classes of animals as a most energetic poison. The symptoms differ in cold and warm blooded animals. In frogs it causes universal paralysis and death without convulsions. In warm blooded animals the gait becomes insecure, and general paralysis ensues. Death is preceded by clonic convulsions. In one of Wormley's experiments, a single drop was placed on the tongue of a large healthy cat. In a few seconds the animal stood still, and showed an unsteady gait when disturbed. In two minutes and a half it fell on its side, voided urine, had strong convulsions and universal tremor, and died in three minutes. The mode of action is somewhat disputed. Like curara it paralyses the ends of the motor nerves and afterwards their trunks. It also seems to have a direct action on the spinal cord (Vertigo) to which the convulsions and paralysis are in some measure due. It has no direct effect on the brain or sensory nerves. In some experiments on animals, conia has been found to occasion tetanic spasms. The pupils have been described as *dilated* and insensible.

Conia—Properties.—When pure, it is an oily, volatile, colourless liquid; but turns yellow and darkens by keeping. It has a pungent odour, as of stale tobacco; gives a greasy pink stain to filtering paper; is very soluble in alcohol, ether, and chloroform; but insoluble in water. With acids it forms salts. It fumes with the vapours of nitric, hydrochloric, and acetic acids. Like the fixed alkaloids, it deposits carbon when heated, and yields precipitates with the iodide of potassium and tannic acid.

Fig. 152.

Fig. 153.

Tests.—*a*. Sulphuric acid causes no immediate change. *b*. Nitric acid deepens its colour, and gives out with it dense white fumes. *c*. Strong hydrochloric acid imparts a pale red tint, which deepens, and leaves groups of needles. *d*. Its vapour, acting on a drop of a solution of carbazotic acid ($\frac{1}{1000}$), develops the crystaline forms, fig. 152, contrasted with the delicate forms arising from a similar reaction with nicotine (fig. 153). *e*. Oxalic acid forms with it a crystalline oxalate of conia.

II. PHYSOSTIGMA VENENOSUM (*the Ordeal Bean of Calabar*).

The seed or bean of the leguminous plant Physostigma venenosum is now imported from Western Africa, and is admitted into the British Pharmacopœia, to which it supplies the extractum physostigmatis. Its chief use is in ophthalmic surgery, as an efficient means of contracting the pupil. We have become acquainted with its action as a poison through the researches of Christison, George Harley, Nunneley, and Fraser. Christison wrote on the subject as early as 1855, and Dr. Fraser has published an exhaustive essay upon it so lately as 1867.*

The bean is about the size of a pigeon's egg, and has the shape of a kidney. It has a hard, shining shell of a deep chocolate colour, and contains two white cotyledons, hollowed and marked as in the annexed illustration (fig. 154), which shows the bean of its natural size and with a vertical and transverse section. The white substance of the bean is free from bitterness, acrimony, or aroma. The absence of any property likely to attract attention or prove repulsive is sufficiently shown by the fact that, in the summer of 1864, fifty children ate the beans at Liverpool, of whom one died. The white cotyledon assumes an orange tint when touched with nitric acid, and a yellowish brown when treated with permurate of iron. The bean owes its activity to an alkaloidal principle to which the name of *physostigmine* has been given.

Fig. 154.

* 'On the Physiological Action of the Calabar Bean.' By Thomas R. Fraser, M.D. ('Trans. Roy. Soc. Edinb.' vol. xxiv.)

but of which the chemical properties have yet to be examined. Its effect in contracting the pupil is eminently characteristic.

Experiments on Animals.—Dr. Fraser describes the effect of a small and of a large dose in terms of which this is an abbreviation. *A small fatal dose*, given to one of the lower animals, first occasions a slight tremor, extending from the hind-quarters to the fore-limbs and head, and then paralysis and muscular flaccidity setting in in the same order. The rectum and bladder are then emptied. The pupils generally *contract*, the breathing becomes slow, irregular, and stertorous, and frothy mucus escapes from the mouth. Muscular twitchings occur, and often continue after respiration has ceased. Reflex action cannot be produced, the parts about the eye are insensible, and on lifting the animal by the ears the limbs hang inert, and a few gasping respirations usher in death. Immediately after death the pupils dilate. Consciousness is evidently preserved. On opening the body, the muscles are found to contract when cut, the heart acts regularly, and the intestines retain their vermicular action. The lungs are excessively engorged. *A large fatal dose* almost immediately paralyses the hind legs; the animal falls, lies flaccid, and shows muscular power only by a few twitches. The pupils contract, and the secretions of the eyes and mouth are increased. Reflex action cannot be produced, and, after a few gasps, respiration ceases. The pupils dilate after death. On opening the body muscular twitchings occur, the heart is found distended, and retains its irritability for about ten minutes. The vermicular action of the intestines is scarcely perceptible.

The poison has proved fatal to every living creature on which it has been tried, except the Esĕrĕ moth; it is a poison of the class to which belong conia and curara.

The effects of doses short of poisonous are well shown in the result of experiments made by Christison on his own person. Twelve grains of the seed, chewed and swallowed, acted in twenty minutes, causing giddiness and torpor. After emptying the stomach by an emetic, the giddiness and weakness continued such as to oblige him to lie down. He was found pale and prostrate, with a weak and very irregular pulse, but the mental faculties intact. Two hours after taking the poison, he felt drowsy, and for other two hours fell into a sort of conscious sleep. The symptoms then gradually went off, and next day he was quite well.* In the children who ate the beans at Liverpool, symptoms of internal irritation were present, with contracted pupil, pale face, and staggering gait.

* 'Pharmaceutical Journal,' 1855, p. 474.

The poison causes contraction of the pupil, whether taken internally or applied externally. In the case of local application of the extract, the effect shows itself in about ten minutes, and lasts for several hours. This contraction of the pupil is, at present, our only test of the presence of this poison. The muscular paralysis which calabar bean so powerfully produces is due to its action on the spinal cord, the excitability of which it first diminishes, and then paralyses, so that it is the direct counterpart to strychnia. Hence its successful employment in the treatment of tetanus. Ultimately it annihilates the excitability of the sensory and motor nerves. Besides its other effects, calabar bean exerts a peculiar influence on the heart, the inhibitory apparatus of which it stimulates. The action is counteracted by atropia.

The treatment of poisoning by the calabar bean would consist in the prompt use of emetics, followed by the measures suited to the state of apnœa. The elaborate experiments of Fraser on the antagonism between physostigmin and atropia ('Trans. Roy. Soc. Edin.,' 1872, xxvi.) indicate that atropia within certain limits is a complete physiological antidote to the lethal effects of calabar bean. Along with other treatment, therefore, the subcutaneous injection of small doses of atropia is indicated in any cases of poisoning with the bean which may present themselves.

III. TOBACCO (*Nicotiana tabacum*).

The Nicotiana tabacum, or Virginian tobacco, belongs, as do so many of our chief poisons—hyoscyamus, belladonna, stramonium—to the artificial class and order *Pentandria monogynia*, and natural order Atropaceæ (fig. 155).

Tobacco contains, as the source of its activity, a liquid volatile alkaloid, and a concrete volatile oil, known as tobacco-camphor. These active ingredients are obtainable from all parts of the plant, and are contained in the infusion and decoction, and in the smoke, blended with carbonate and acetate of ammonia, and several gases. The dried leaves have a place in the British Pharmacopœia, and supply the enema tabaci—twenty grains to eight ounces.

Symptoms.—Tobacco, or its alkaloid nicotine, in small dose causes local sensations in the mouth and fauces of warmth or burning accompanied by salivation. This is followed by unpleasant nausea and vomiting, and an excessive feeling of depression and muscular weakness. The pulse is either quickened or retarded; frequently the latter. The skin becomes pale and cold, and the functions of the brain and nervous system generally, prostrated.

The pulse intermits, and death takes place preceded by clonic convulsions. Occasionally, if the dose is very large, death may occur under sudden prostration and without convulsions.

The poisoning may result from the smoking of tobacco, as well as from its absorption in substance. Marshall Hall relates the case of a young man who smoked two pipes for his first debauch, and was seized, in consequence, with nausea, vomiting, and syncope, then with stupor and stertorous breathing, general spasms, and insensible pupil. Next day the tendency to faint continued, and in the evening the stupor, stertor, and spasms returned, but from that time he recovered steadily. Other authors have reported cases of death from excessive smoking. The effects of tobacco smoke have been generally attributed to the nicotine which it contains; but Vohl and Eulenburg attribute them rather to the final products of combustion—viz., pyridin and picolin bases. But Heubel has more recently supported the generally received notion that undecomposed nicotine is really contained in the smoke. Fatal results also sometimes follow the introduction of the infusion or smoke into the bowels; and severe effects have also followed the abuse of snuff, external application of tobacco, and sleeping surrounded by bales of the weed; or by smugglers carrying tobacco next the skin for purposes of concealment.

Fig. 155.

Commencement of Symptoms.—After a few minutes.

Fatal Period.—Shortest, eighteen minutes.

Fatal Dose.—Half a drachm (Copland).

Post-mortem Appearances.—Not very characteristic. Turgescence of the vessels of the brain, and inflammation of the stomach have been found.

Treatment.—If taken in substance, and not discharged by

spontaneous vomiting, emetics must be first administered. The after-treatment must consist in the free use of stimulants.

NICOTINE (*Nicotia*).—This alkaloid has acted fatally as a poison in two instances: one in Belgium in 1851, when it was administered by Count Bocarmé to his brother-in-law, the other in London in 1858, the act being suicidal. The alkaloid acts with the rapidity, and somewhat after the manner, of prussic acid. The victim of Count Bocarmé does not seem to have survived five minutes; and in the suicidal case death was quite as rapid. The patient was observed to stare wildly, and to die without convulsions, while heaving a deep sigh.

The *post-mortem appearances* in this case were general relaxation of the muscular system, staring eyes, bloated and livid features, the vessels of the scalp and membranes of the brain, and those of the lungs, gorged with black blood, and the cavities of the heart, with the exception of the left auricle, empty. There was intense congestion of the mucous membrane of the stomach and of the liver. The blood was black and liquid, and, in some parts, had the consistence of treacle. Nicotine was detected in the stomach, liver, and lungs, by a process similar to that of Stas.*

Experiments on Animals. Nicotine is a most active poison. A single drop is sufficient to kill a cat or rabbit in two to three minutes. In frogs it usually causes clonic, rarely tonic, convulsions. The fore legs become fixed at right angles to the trunk, and the hind legs are extended and curved (Van Praag). Convulsions are also caused in warm-blooded animals. Nicotine affects the brain, and also acts on the spinal cord; at first exciting it (hence the convulsions), and ultimately paralysing it. The intracardiac ganglia are similarly acted on, and so are also the peripheral motor and vaso-motor nerves; all being at first excited, and then paralysed. The methyl derivatives of nicotine do not cause convulsions (Brown and Fraser), but act like curara.

Properties.—Nicotine resembles conia in being a liquid and volatile alkaloid. When quite pure it is a colourless oily liquid, but assumes an amber hue on exposure to the air, and deepens in tint by keeping. A drop placed on a white surface of enamelled glass has a green colour, while conia is pink; and if the liquids are dropped on filtering paper, they produce greasy stains of the same colours. Nicotine has an acrid taste, but a pleasant ethereal odour;† while conia has a disagreeable odour, resembling

* See Taylor, 'On Poisons,' p. 750.

† This odour has been retained by two specimens now for many years in my possession. (G.)

that of stale tobacco. Nicotine is soluble in water and in alcohol, ether, and chloroform—its best solvent. The three mineral acids do not change the colour of the alkaloid. With the vapours of the two volatile acids, it yields white fumes less dense than those with conia. The aqueous solution has a decided alkaline reaction. With acids, the alkaloid forms fixed salts, and with several reagents characteristic crystallizable compounds.

Tests.—a. Nicotine resembles conia and the fixed alkaloids in the effect of heat, and in the precipitates which it yields with the solution of iodine in iodide of potassium, and with tannic acid. *b.* Sulphuric acid combines with it without change of colour. *c.* Nitric acid also does not change the colour of the alkaloid. *d.* Corrosive sublimate throws down a white deposit, which is found to consist of well-defined groups of transparent plates, arranged as flowers, winged insects, and rosettes. *e.* Bichloride of platinum yields a well-marked precipitate. *f.* Carbazotic acid also yields a distinct crystalline precipitate. *g.* Oxalic acid gives with the alkaloid crystals of oxalate of nicotine.

In some of these reactions nicotine resembles ammonia. It is sufficiently distinguished from it by the fact, that ammonia reddens tannic acid, and gives with the solution of iodine in iodide of potassium a dark-green precipitate.

IV. LOBELIA (*Lobelia inflata, Indian Tobacco, Bladder-podded Lobelia*).

Lobelia inflata belongs to the artificial class and order *Pentandria monogynia*, and natural order *Lobeliaceæ*. It is a native of North America, and has long been used by the aborigines: it at length became a quack medicine among the American irregular practitioners, was the subject of favourable notice by a clergyman (Dr. Cutler), and of a work by an English physician, Dr. Reece, in the year 1829, in which work it was highly commended as an *anti-asthmatic*.

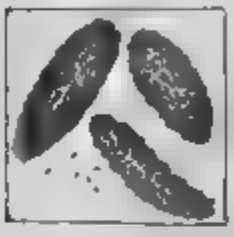
The herb is usually imported in compressed oblong cakes weighing half a pound or a pound each. The seeds, and a powder of the seeds, are sold by all the herbalists. Both have proved fatal several times in America and in England.

The dried herb is of a pale green colour; it has a nauseous odour, and acrid burning taste, closely resembling that of tobacco. The taste and odour are believed to be due to a volatile oil, to a resinous alkaloid (lobelin), and to a peculiar acid.

The dried herb has a place in the British Pharmacopœia, and yields two tinctures—the tinctura lobeliæ, and tinctura lobeliæ

ethereo (2½ ounces to the pint, and dose ten to thirty minims).

Fig. 156.



The seeds are small brown grains, and weigh 3176 to a grain. They have the size, shape, and microscopic characters depicted in fig. 156.

Lobelia is an active medicine, and a potent poison. In ten grain or scruple doses of the powdered leaves or seeds it is a strong but unseating *emetic*, and has been termed the *emetic weed*. A teaspoonful, or a drachm, is a fatal dose.

Symptoms.—Speedy vomiting followed by distressing nausea with headache, giddiness, and tremors, copious sweats, and extreme depression, are the leading symptoms. Diarrhœa and dysuria are sometimes present. Sometimes the pulse intermits as a consequence of its depressant effect on the circulation. The fatal event is ushered in by convulsions. Employed as an enema it acts as tobacco does, causing the same sickness and tendency to faint.

Fatal Dose.—A case of poisoning by a drachm of the powdered leaves occurred in England in 1847.

Fatal Period.—In this case death happened in about thirty-six hours.

Post-mortem Appearances.—The mucous membrane of the stomach intensely inflamed, and the vessels of the brain strongly congested.

Treatment.—This consists in promoting vomiting by draughts of warm water, and tickling the throat, followed by the free use of stimulants to counteract the depressing effect of the poison.

V. CURARA (*Woorara, Woorali, Urali*).

Curara is the South American arrow poison, and is believed to be prepared from some species of strychnos. It occurs as a brittle, brownish-looking extract, exhibiting a shining fracture. It is easily soluble in water. The active principle is curarin (Preyer), a crystallizable alkaloid soluble both in water and alcohol. Curara and curarin have a similar action.

Symptoms.—The symptoms of poisonous doses in man have not been recorded. When injected subcutaneously in frogs it speedily causes paralysis of all the voluntary muscles. The paralysis commences in the hinder extremities, and ultimately the animal lies as if dead, the heart alone continuing to beat. In larger doses the heart also becomes paralysed. In warm-blooded animals

the effects are similar—paralysis of all the voluntary muscles ensuing and causing death by affecting the muscles of respiration. The heart is also affected by paralysis, but later. Occasionally convulsive action of the muscles is observed before death. Lachrymation and salivation also occur among the symptoms. In animals poisoned by curara the urine becomes diabetic. The effects are due to the paralysing influence which the poison exerts on the motor nerves, first on those of voluntary motion, next those of the blood-vessels, and lastly those of the heart. The contractility of the muscles themselves remains unaffected. Analogous in their action to curara are the methyl compounds of strychnia and brucia (Brown and Fraser). The substitution of methyl causes these convulsives to exert an action the direct opposite of that which properly belongs to them. Curara acts only by introduction into the blood either directly or by a wound. If introduced into the stomach it produces little or no effect. The explanation seems to be that excretion goes on as rapidly as absorption from the stomach, so that there is never enough in the circulation to cause poisoning. Hermann has shown that if the renal vessels are tied, poisoning results from the introduction of the substance into the stomach as surely as if it were directly introduced into the blood.

Treatment.—The treatment of poisoning by curara is by artificial respiration, which brings about recovery in animals if the dose has not been so great as to paralyse the action of the heart.

CHAPTER XIV.

ASTHENICS.

I. HYDROCYANIC ACID. II. OXALIC ACID. III. ACONITE. IV. DIGITALIS. V. VERATRUM ALBUM.

THE poisons here grouped together occasion death by *asthenia*, or shock. They have all a direct action on the heart and circulation, and the first two destroy life very quickly; but their effects on the heart are not among their most marked characteristics. They are also strongly contrasted, especially in the absence of corrosive action in the one and its presence in the other. The last three poisons are *strikingly characterized by their action on the heart*, and are therefore usually grouped together as *cardiac poisons*; to which class also belong the Antiaris toxicaria, antiar, or upas; the Dajakh of Borneo, and the Tanghinia venenifera. Veratria has been transferred to this group from the place among the Hellebores which it occupied in the last edition of this work.

I. HYDROCYANIC ACID.

Hydrocyanic, or prussic acid, essential oil of bitter almonds, of which it is the active principle, and cyanide of potassium, one of its salts, form a group of poisons ranking next in order to opium and its preparations.

In the two years 1837–8, twenty-seven cases of poisoning by prussic acid came under the notice of the coroner's court, of which eight (all cases of suicide) occurred in medical men and druggists. Four cases of poisoning by essential oil of almonds also occurred in those years, and one by prussic acid and arsenic. Prussic acid, with its preparations and compounds, therefore caused, on the average of those years, sixteen deaths. But on the average of the five years 1852–56, they were credited with 34 deaths; so that the use of this poison is on the increase.

In the five years, 93 deaths were attributed to prussic acid, of which 83 in males and 10 in females; 75 to essential oil of almonds, of which 45 in males and 30 in females; and 2 to cyanide of potassium, one in a male the other in a female. There

was one murder only, and that by the essential oil of almonds. The remainder of the deaths were suicidal or accidental; and 75 by prussic acid, 51 by essential oil of almonds, and 1 by cyanide of potassium were ascertained suicidal acts.

The quick and fatal effect of this poison, coupled with the frequent use of the essential oil in cookery, and of the cyanide of potassium in the arts, renders it a favourite instrument of suicide. For medicinal purposes, the acid is formed by a complex chemical process, or by the decomposition of salts which contain it; but its elements also exist in the leaves, flowers, and fruit-kernels of many plants belonging to the natural order Rosaceæ. The bitter almond, cherry-laurel, peach, cluster cherry, and mountain ash; the kernels of peaches, plums, cherries, and the pips of apples contain the acid, which, mixed with an essential oil, distils with it. The cherry-laurel water was given as a poison in the well-known case of Sir Theodosius Boughton; and a bitter almond water improperly kept in the shops of very variable strength, and incautiously prescribed, has also proved fatal.

The poison exists in two forms: as the pure anhydrous acid, and diluted with water. Both are colourless. The first has an acrid pungent taste, and a peculiar odour; is highly inflammable; boils at 80°, freezes at 5°, and at common temperatures by its own evaporation. Exposure to light soon decomposes and turns it brown. The pure acid has no medico-legal interest: it is the dilute acid of the shops that is commonly used as a poison.

Dilute Hydrocyanic Acid.

Properties.—The dilute has the same appearance, odour, and taste as the strong acid, but if kept from the light is less apt to decompose. It is volatile, and loses strength by exposure. The strength of the acid differs with its age, and the mode of preparation, from 1·3 to 6·5 per cent. (Taylor.) That resulting from the decomposition of a solution of ferrocyanide of potassium by sulphuric acid is much more stable, and may be kept for years exposed to diffused light without change.

The strength of the acid, as used in different countries, varies greatly. The acid of the British Pharmacopœia should contain about 2, that of Vauquelin 3·3, and that of Scheele 5, per cent.

Among the properties of prussic acid just described, there is one so characteristic and delicate as to constitute a test, namely—

The odour.—This is perceptible even in weak specimens; has the advantage of not demanding chemical knowledge or skill in the observer; and when perceived by several persons is conclusive. It has, indeed, been alleged that nitro-benzine, a product of coal-

tar, and brain tissue have a like odour. Of nitro-benzine suffice it to observe that it is itself an active poison (see p. 567); of the faint similar odour of the brain, that it is not often perceived; and of both that they are very unlikely to constitute real objections.

The odour finds its application as a highly characteristic property and test during life diffused through the air, or perceptible in the breath; after death, at the mouth, in the contents of the stomach, and in the tissues. But in patients under treatment, it may be disguised, as in the case that fell under my observation, in which assafœtida was used in an injection (G.); and in the dead body, though generally recognisable soon after death, it may disappear in less than twenty-four hours. In the case of Sarah Hart, the victim of Tawell, it was perceived by two only out of five witnesses, eighteen hours after death; in one reported by Mr. Newham, of Bury St. Edmunds, after eleven hours in the stomach, heart, and brain; and in an interesting case of double suicide (that of C. W. Duckett and Elizabeth Williams, reported by Dr. Letheby), about the mouth twelve hours, and according to Mr. G. Davies, seventeen or eighteen hours, after death.

Tests.—In addition to the odour, there are four other recognised tests equally applicable to the acid in solution and in vapour, which may be designated as the copper, silver, iron, and sulphur tests.

1. *Copper Test.*—To the liquid rendered slightly alkaline by liquor potassæ, add a solution of sulphate of copper. A greenish-white precipitate is thrown down, which, on adding a little hydrochloric acid (to redissolve the blue oxide), becomes nearly white.

2. *Silver Test.*—A solution of nitrate of silver gives with liquids containing hydrocyanic acid a white clotted precipitate, insoluble in nitric acid at common temperatures, but soluble at a boiling heat. If the precipitated cyanide of silver, washed and dried, is introduced into a small tube closed at one end, and drawn out at the other into a fine point, and the precipitate is heated by the flame of a spirit-lamp, cyanogen gas is driven off, which, on being lighted, burns with a highly characteristic crimson flame, surrounded by a blue halo.

3. *Iron Test.*—Add to the suspected liquid a little liquor potassæ, then a few drops of the mixed protosulphate and persulphate of iron in solution. A brownish-green precipitate is thrown down, which, on the addition of a little dilute hydrochloric acid, becomes Prussian blue.

4. *Sulphur Test.* (Liebig's Test.)—To the liquid containing

the acid add a few drops of sulphide of ammonium; heat the liquid gently till it becomes pure white or colourless; then evaporate slowly. A white amorphous sulphocyanide of ammonium remains, which assumes an intense cherry-red colour when touched with a solution of perchloride of iron: a colour which is discharged by corrosive sublimate, and so distinguished from a similar colour produced with meconic acid.

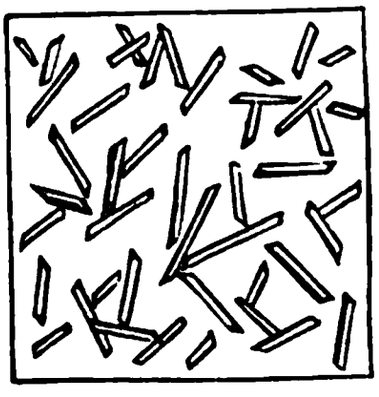
When these tests are applied to detect the acid by its *vapour*, the following method of procedure is to be observed:—

Place the fluid or substance yielding the vapour in a watch-glass; moisten a large flat disk of glass with the test; invert it over the watch-glass, with the moistened surface downwards, and allow it to remain till a distinct reaction is perceptible through the disk.

In the case of the *copper test* moisten the glass disk with a drop of a weak solution of sulphate of copper (1 grain to the ounce) rendered slightly alkaline by liquor potassæ; and after exposure add a drop of dilute hydrochloric acid. Compare the dried stain with that from a drop of the copper solution.

In the case of the *silver test*, moisten the glass disk with a weak freshly made solution of nitrate of silver (gr. 1 to f℥j) and expose it to the vapour. The spot soon becomes opalescent, and when dry, leaves a white stain, which, examined by the microscope, is found to consist of distinct prisms, or long plates, more or less thickly interlaced (fig. 157). Compare the stain with that left by a drop of the silver solution. It is faintly white and has no distinct crystalline form.

Fig. 157.



In the case of the *iron test* moisten the glass disk with a drop of liquor potassæ, and after due exposure add a drop of the fresh solution of the mixed sulphates of iron. Develope the Prussian blue by dilute hydrochloric acid. Compare with the Prussian blue the brown oxide of iron thrown down by adding liquor potassæ to the test liquid.

In the case of the *sulphur test*, moisten the glass disk with sulphide of ammonium, allow the white stain of cyanide of ammonium to dry, and test with a drop of perchloride of iron solution, so weak as to be nearly colourless. Compare the cherry red of the sulphocyanide with the yellow of the dry spot of the perchloride. As the liquid in the watch-glass absorbs some of the vapour of the sulphide of

ammonium, and turns white, it may be allowed to dry, and b tested with the perchloride of iron.

Of these four tests of prussic acid in vapour, I have found the silver test the most satisfactory. A single apple-pip bruised an moistened with distilled water, and placed in a watch-glas yielded as many as twenty-two distinct reactions. The solutio of nitrate of silver was rendered opalescent in every instance, an the dried stain was found to contain microscopic crystals of th cyanide. The results obtained with the other tests in experi ments made under exactly similar circumstances, were les satisfactory. Three apple-pips were bruised, moistened, an placed in three watch-glasses; and the three tests were used i the manner already described for ten successive exposures of fi minutes each. The nitrate of silver acted characteristically i all; the Prussian blue test succeeded in three; and Liebig's te in one. But in the last experiment the liquid in the watch-glas was whitened by the sulphide of ammonium, and, when dry yielded a white stain, having a characteristic reaction with th per-salt of iron. (G.)

Hydrocyanic Acid in Organic Mixtures.

The acid being highly volatile, the examination of all organi liquids and substances supposed to contain it, should be mad without delay.

For the detection of hydrocyanic acid in such organic matter and liquids we resort to a process of distillation. But previou to doing so, we may apply the four tests to the vapour given off The process of distillation is conducted as follows:—

The filtered liquid, if alkaline, is neutralized by sulphuric acid which will fix any ammonia generated by putrefaction. It i then to be distilled from a water-bath, at about 150° Fahr., til about an eighth part has passed into the receiver. This fluid may then be tested by the reagents just described.

It has been objected to this, and every other process in whic heat is employed, that hydrocyanic acid may be formed during distillation by the decomposition of animal matter. This is a mere conjecture, unsupported by experiment. It has also bee objected that the acid may be formed in the course of the putre faction and decay of various animal and vegetable matters, such as cheese and the ergot of rye.

These objections are futile in all those cases in which persons are found dying or dead with the odour of prussic acid strong upon them; and in many cases they are effectually removed by analysing the secretions of the body itself, such as the serum of

the brain. In a case which I saw during my pupilage, hydrocyanic acid was readily detected by its odour in all parts of the body, and was found in the brain by Mr. Everett. (G.)

Quantitative Analysis.—Use for this purpose the precipitated cyanide of silver, every 100 grains of which correspond to 20·33 grains of the pure anhydrous acid.

EXPERIMENTS ON ANIMALS.

Hydrocyanic acid in all its forms is a most energetic poison. Animals made to breathe air saturated with the vapour of the anhydrous acid, die instantaneously (Pereira), or in from one to ten seconds (M. Robert). The fluid anhydrous acid acts nearly as rapidly. A single drop put into the throat of a dog killed it after two or three deep hurried respirations; it acted almost as quickly when dropped under the eyelid; and when injected into the jugular vein, the animal fell dead at the very instant, as if struck with a cannon ball, or with lightning (Magendie). A single drop in the mouth of a rabbit began to act in sixty-three seconds, and killed it in eighty-three; three drops began to act on a cat in ten seconds, and on another in five, killing the first in thirty seconds, and the second in forty; four drops began to act on a rabbit in twenty, and killed it in thirty, seconds; and a quantity equivalent to an ounce and a half of medicinal acid, began to act on a rabbit directly it was poured into its mouth, and killed it outright in ten seconds at furthest. Three drops projected into the eye, acted on a cat in twenty seconds, and killed it in twenty more, and the same quantity dropped on a fresh wound in the loins, acted in forty-five seconds, and proved fatal in one hundred and five. In the slower cases, there were violent fits of tetanus; but in the very rapid cases the animals died just as the fit began to show itself with retraction of the head. In rabbits the spine was bent back, in cats it was curved forwards. (Christison.)

The concentrated acid, then, according to its quantity, and mode of administration, may begin to act on the animals usually submitted to experiment instantaneously, or in from five to sixty-three seconds, and may kill in from ten to one hundred and five. When dropped into the mouth it may begin to act in from five to ten, and prove fatal in from thirty to forty, seconds.

The effects of the dilute acid on animals have been reported by several observers. Mr. Nunneley, of Leeds, who made a very large and carefully conducted series of experiments, mostly on dogs, shows that a large dose of the dilute acid kills as quickly as the concentrated acid; and that moderate dilution not only does

not impair, but even somewhat enhances its effects. Large doses of the dilute acid destroy life in from two to fifteen minutes; but life may be prolonged, after a fatal dose, for hours or even days. A dog poisoned by Coullon died after nineteen days of suffering.

When the dose is short of a fatal one, the animal is seized in one or two minutes with giddiness, weakness, salivation, and protrusion of the tongue, hurried, panting respiration, livid face, and protrusion of the eyes, with convulsions or tetanic spasms, passing into paralysis, and insensibility. After lying in this state some time, sensibility and power of motion are gradually restored, with slight convulsions and gasping respiration, and sometimes with strong convulsions and loud howlings. The animal then falls into a sleep, sometimes so profound as to resemble the effects of opium, and wakes up recovered but feeble. The breath of the animal has the odour of the poison. In cold-blooded animals, such as frogs, the poison kills without causing convulsions.

Several questions of obvious medico-legal importance relating to the symptoms of poisoning by prussic acid have been illustrated by experiments on animals.

Convulsions.—The question, whether convulsions are among the common symptoms of poisoning by prussic acid has been answered in the affirmative. They are generally present, but frequent exceptions to the rule are recorded by almost all who have experimented largely on animals.

The Shriek or Cry.—This too is a common, but not constant, symptom. It is described by Mr. Nunneley as "a peculiar cry, indicative of severe distress, different from anything heard in any other state," and as he believes "characteristic of the poison." In his numerous experiments on dogs it was present in only one-half the cases.

Expulsion of Fæces and Urine.—The fæces alone were passed in about a tenth of the cases; in another tenth both fæces and urine; in a far larger number the urine alone; and in about two-fifths of the whole neither fæces nor urine (Nunneley.)

Acts of Volition. Such acts are often performed before the poisonous effects show themselves. One dog, after taking the poison, "went down three or four steps of some stairs, saw the door at the bottom was closed, and came back again;" and another "went down, came up, and then went down again the whole flight of a steep winding staircase," and a third "retained sufficient vigour to jump over one of the dogs, and then actually leaped completely across the open top of the staircase." (Nunneley.)

The *post-mortem appearances* in the animals submitted to ex-

not well marked. The brain has generally a natural
ıough its vessels have been found turgid, and in one
ıe horse) there was extravasation of blood between
ıembranes. The heart and great vessels differ in
ıd contents, according as death occurs quickly or
ıses of sudden death, the left side of the heart is, in
ɔase, perfectly empty and rigidly contracted, while
ntains blood, sometimes in large quantity. In
both sides of the heart are distended with black
ley). Sometimes the blood is florid; but usually it
colour of the blood in asphyxia. In frogs poisoned
cid, the heart is found dilated, and filled with bright
is colour of the blood is attributable to an alteration
ɔf the corpuscles, so that they reflect light more
ɔrding to Magendie, the pure acid so completely
rritability of the heart and voluntary muscles, that
sible even to the stimulus of galvanism. But "in
ients on cats and rabbits with the pure acid the
ɛed spontaneously, as well as under stimuli, for some
ıth, except in the instance of the rabbit killed with
rains, and one of the cats killed by three drops ap-
ɔngue. In the last two the pulsation of the heart
ıe short fit of tetanus which preceded death; and
whose chest was laid open instantly after death,
ıs gorged, and its irritability utterly extinct."
The lungs are sometimes empty, but more fre-
d with blood. The membrane to which the acid is
ally found congested. The corpse is generally very

of prussic acid is not yet in all respects satisfac-
ned. For a very exhaustive memoir on the subject
ı referred to the recent work of Preyer, 'Die
Prussic acid is a universal poison both to plants
imal tissues and organs. Preyer attributes the chief
ıction on the vagus, and interference with the re-
res. The convulsions he regards as being essen-
' asphyxia.

, POST-MORTEM APPEARANCES, AND TREATMENT.

—The symptoms of poisoning by prussic acid in the
t vary, as experiments on animals would lead us to
he dose, and with the age, strength, and state of
When the dose is large, the symptoms begin in a
r minutes. There is probably, in all cases, a short

interval of consciousness, and then a sudden access of giddiness, rapidly followed by insensibility, deep catching respiration, and speedy death. When the case is prolonged beyond a few seconds, or minutes, other symptoms are superadded.

The symptoms of the fatal cases and those of greatest severity are:—insensibility, deep catching respiration, loud mucous rattle, cold and blue skin, dilated pupil, very rapid pulse and breathing, rigid contraction of the jaw, tetanic spasms or strong convulsions of the extremities, and, in some cases, discharges of urine and fæces. In protracted fatal cases, and in rare cases of recovery, the leading symptoms are dyspnœa, loud mucous rattle, slight convulsions, and salivation. In acute cases, the cause of death resembles shock, in chronic cases, suffocation. In rare instances narcotic symptoms are present, as in poisoning by opium.

The short interval of consciousness which, as just stated, probably occurs in all cases, is sometimes filled in by voluntary acts. But a few persons, after swallowing large doses, have staggered a few steps, fallen without a groan, apparently lifeless, and died after a few convulsive expirations, in less than four minutes after swallowing the poison; others have uttered expressions of fear, and then fallen as if struck by lightning. In many cases they have been heard to fall without uttering any sound.

In smaller doses, the poison occasions nausea, salivation, followed sometimes by ulceration of the mouth, a rapid pulse, and weight and pain in the head, succeeded by a feeling of anxiety lasting several hours.

Post-mortem Appearances.—The countenance is pale and composed, the eyes glistening, the venous system gorged with blood of a glimmering blue tint, the brain congested, with serous effusion into the ventricles. Traces of inflammation, or of congestion, of the mucous membrane of the stomach, in patches or spots, congestion of the lungs, and a deep blue colour of the bile, have been mentioned among the occasional appearances. Putrefaction makes rapid progress, as in most other forms of sudden death.

The stomach and every part of the body exhale the odour of prussic acid; but not in all cases. It may be expected to be absent when the patient lives long enough to exhale it freely from the lungs, or where the body has been for some time placed under circumstances favourable to evaporation. It has been recognised in the stomach, and not in other parts; and in other parts when there was no trace of it in the stomach. The odour is most conclusive when perceived in the blood or limbs; for it is said occasionally to exist in the stomach and intestines.

and in the brain, where no substance containing prussic acid has been taken.

Treatment (*Antidotes*).—Chlorine and the mixed oxides of iron act as antidotes to prussic acid, the one by withdrawing the hydrogen of the poison, the other by forming with it the insoluble Prussian blue. But there are few cases in the human subject in which an antidote can be applied, and none in which to prepare an antidote would not be to lose valuable time. In the great majority of cases the medical man is called to a suicide already dead, or *in articulo mortis*; and when the patient is still alive, the jaw is so firmly closed as to render the introduction of an antidote very difficult, if not impossible.

The first step to be taken is to administer the *cold affusion* as a shock, by water dashed into the face, or freely poured on the head and back. As soon as the patient is roused, though still insensible, and perhaps in convulsions, he must be undressed, wiped dry, and put to bed. An attempt may now be made to pass a feather to the back of the throat to promote vomiting, and a sponge or rag sprinkled with disinfecting fluid may be held to the nostrils, the surface being kept warm by hot cloths or flannels, and by frictions with the hand or flesh-brush. As soon as the jaws can be opened, and the patient be made to swallow, an emetic of sulphate of zinc, of mustard, or of common salt, should be given; or the stomach-pump may be employed.*

Fatal Dose.—This may be stated for the adult at somewhat less than a grain of the pure acid, or about 45 minims of the acid of the British Pharmacopœia. Very severe symptoms have been caused by about half a drachm of this acid, but recovery has taken place from doses of seventy or eighty drops.

Commencement of the Symptoms.—There are no cases on record of that instantaneous action in the human subject which has been noted in experiments on animals. But when the dose of the acid is large the symptoms set in very soon, and death quickly follows. In a case reported by Hufeland a quantity equivalent to forty grains of the pure acid was taken. The man was seen to swallow the poison, was observed to stagger a few steps, and then to sink without a groan, apparently lifeless. But after smaller fatal doses, or doses productive of severe effects, a short interval elapses between the taking of the poison and the loss of sense and power. The voluntary acts that can be performed in this interval will be presently ascertained by an appeal to cases.

* Preyer recommends the subcutaneous injection of atropia as a physiological antidote to the action of hydrocyanic acid on the vagus.

Fatal Period.—After a large dose, death takes place in from two to five minutes. But it may not happen till twenty minutes, half an hour, three-quarters of an hour, or an hour; and patients may continue in imminent danger for several hours, and yet recover.

Voluntary Acts.—The question whether, after taking a large dose of prussic acid, the patient retains his consciousness for a time, so as to be able to perform certain voluntary acts? is an important one. In favour of the retention of consciousness I have the distinct statement of the patient whose case will be presently cited (G.); and that many voluntary acts may be performed in this conscious interval is proved by several recorded cases. The medico-legal import of the question will be understood from the following case:—

An apothecary's maid-servant at Leicester, pregnant by Freeman, her master's apprentice, was found dead in bed, poisoned with prussic acid. The apprentice was suspected of having been accessory to her death; but, as it was proved that the deceased had made preparations for effecting a miscarriage, she might have taken the poison of her own accord. The question of suicide or homicide could be answered only by a reference to the condition in which the body was found. It appeared, from the evidence, that the body lay at full length on the bed, with the head turned a little on one side, the arms crossed over the trunk, and the bedclothes pulled smoothly up to the chin; under the clothes, on her right side, lay a corked phial, wrapped in paper, and containing three drachms and a half of the poison. The leather and string which had fastened the cork were found in the chamber-vessel.* It was probable, therefore, that four and a half drachms of the poison had been swallowed; and the question arose, Could the girl, after taking this quantity of the poison, have corked the bottle, wrapped it up, and adjusted the bedclothes?

This question can be answered only by an appeal to fatal suicidal cases in which similar acts of volition have been performed; or by comparing the time which such acts occupy with ascertained intervals of consciousness. The experiments on animals performed by some of the medical witnesses examined in this case, though useful as illustrations, are quite inconclusive.

The following facts may be cited in illustration:—An apothecary's assistant in Germany took four ounces of the acid of the Bavarian Pharmacopœia, and was found dead in bed, with an empty two-ounce phial on each side of the bed, the bed-covering

* See this case very fully reported, 'Medical Gazette," vol. viii. p. 739.

igh as the breast, the right arm extended beneath
eft arm bent at the elbow. In a suicidal case
Ir. Newham, the bed-clothes were smoothly drawn
lders; and on a chair close to the back of the bed
ith the cork in it. A third case of the same kind
ated to Dr. Taylor by a pupil. A man found dead
f a water-closet, had the bottle from which the
ken corked in his pocket. In a curious case of
reported by Dr. Letheby, the bodies were found in
h implied a succession of slight voluntary move-

prove the possibility of slight voluntary efforts
ter a large dose of prussic acid; and they justify,
uestion is concerned, the verdict of acquittal pro-
our of Freeman.
untary acts that may be done after fatal or highly
es of this poison go much beyond those inferred
tion of the bodies in these instances. In the
presently to be more minutely described, as one of
six hours of imminent danger, the lad took a large
ison in bed; but he got out of bed, walked round
to a chest of drawers distant two or three yards,
pper firmly in the phial, and returned to the side
n which he fell senseless.
class of cases the suicide, besides other movements
ion, has been able to cry for help and even to

ary's apprentice sent from the shop to the cellar
a few minutes away when he was heard to cry, in
Hartshorn! hartshorn!" On rushing downstairs,
s found him lying on the lower step, grasping the
ad scarcely time to mutter, "Prussic acid!" when
ore than five minutes after leaving the shop. He
rachm of the Bavarian acid, had tried to get at the
had not strength to uncover the bottle.
s reported by Mr. Nunneley, the patients not only
but spoke and answered questions, after taking, the
e other a large dose of the poison. The subject of
answered a question some minutes after he had
on, and the man who recovered retained the use of
jaws gradually closed.
adriac gentleman, having locked himself in his room,
achms of prussic acid of the estimated strength of
:., but after about a minute he unlocked the door,

and cried out, "Come to me quick, I am dying." A servant immediately entered the room, and found him lying on his back on the sofa, with his legs crossed, insensible, and snoring. Dr. Sewell arrived in twenty minutes. He was then dead, and presented the appearance of profound slumber; legs crossed, arms by his sides, and eyelids firmly closed.*

The effects of prussic acid taken in a large, but not fatal, dose will be seen by the two cases which follow. The first is described in the 'Revue Médicale' for February, 1845, the second came under my own observation in the previous year. (G.)

Dr. B——, a physician at Rennes, having taken, without inconvenience, a teaspoonful of prussic acid, prepared by himself, in the morning, and a second, prepared after Scheele's method, after dinner, took a third teaspoonful of a preparation purchased of M. Vauquelin, and after an interval of a few seconds, another. This new preparation tasted a little stronger, and Dr. B—— remarked that "it had not hurt him;" but, on walking out of the shop, he felt an alarming disturbance in his head, and, on returning, uttered a few expressions of fear, and fell down as if struck by lightning. The teeth were firmly closed, there was continually-increasing dyspnœa, with noisy rattling respiration, cold extremities, distortion of the mouth, redness and swelling of the face and neck, fixed and dilated pupil, and a pulse imperceptible in the left, and very small in the right arm. The trismus became more marked, a short and violent convulsion ensued, and the abdomen, specially about the epigastrium, became rapidly distended. Attempts were now made to rouse him by stimulant frictions with ammonia and cantharides, and by other stimulant applications; and on tickling the throat with a feather, some dark-coloured mucus was discharged. After remaining in this state for two hours and a half, he showed signs of returning consciousness, and recognised those around him. The mental faculties were gradually restored, but considerable difficulty of breathing and very distinct rattle remained, with occasional expectoration of yellowish black mucus. During the whole of this time the breath smelt strongly of prussic acid. Dr. B—— was thirteen days before he could go out to see his patients, during which time the dyspnœa was frequently distressing, particularly when he turned in bed, and when he awoke in the morning. At last he quite recovered. During the first four days very little urine was passed.

* This case is reported by Dr. Sewell of Montreal. For full details of some of the cases just cited, and for additional cases, refer to Ranking's 'Half-yearly Abstract of the Medical Sciences,' vol. ii. p. 399.

In the winter of 1844, I was called up at night to see a young gentleman who had swallowed prussic acid. The facts of the case, as detailed by himself and his relatives, are as follows:—

He is the son of a medical man, is about nineteen years of age, and studying the law. His disposition is naturally cheerful; his habits are temperate and industrious; he has met with no disappointment; and, till now, has never contemplated suicide. On the afternoon of the day on which he swallowed the poison he dined in the Hall of one of the Inns of Court, and drank much more wine than he was in the habit of taking. When he got home he was observed to be somewhat the worse for liquor, and before going to bed went into the surgery, from which he took a stoppered bottle, believed to have contained from one to two drachms of prussic acid of Pharmacopœial strength, but according to his own statement, about a mouthful. Soon after he had gone to bed the family was startled by a noise in his room as of a heavy body falling, and a relative passing at the time, was alarmed by a loud gurgling noise. His father was almost immediately on the spot, and seeing the bottle on the drawers, dashed several buckets of water over the face and chest. This roused him. He was then taken into an adjoining room, and put to bed, the treatment consisting in holding ammonia to the nostrils, and applying heat to the spine and feet. An injection was also given, containing tincture of assafœtida.

When I reached the house I found him in the following state, in which he had continued without alteration for three hours:—He lay on his back, drawing in his breath with great effort, and a loud gasping sound, with a distinct mucous râle. The pulse was upwards of 140 in the minute, and the respiration 36. The surface very cold; the countenance of a dull leaden hue; the lips blue; the pupil extremely dilated; and the jaws rigid, in which state they had remained for the whole period, so that it had been impossible to administer any antidote.

The treatment from this time consisted in ammonia to the nostrils, assiduous frictions with the flesh-brush, and the application of heat to the surface by means of warm flannels. At the expiration of about five hours there was some effort to vomit, encouraged by tickling the throat, and some bloody mucus was wiped from the mouth. Soon afterwards he could be made to swallow, when some warm brandy and water and strong coffee were given him. At this time, too, he could answer in monosyllables, and raise himself on his elbows: was perfectly sensible, but looked bewildered. At the end of about six hours he was sufficiently recovered to answer questions, move himself about,

and call for lemonade, which he drank freely. The mucous rale had disappeared, the respiration and pulse were still frequent, the pupil was restored to nearly its usual size, and the skin was warm. Being disposed to be quiet, and seeming out of danger, he was left to himself. After a time he complained of fulness at the stomach, and asked for an emetic, which brought off a large quantity of undigested food.

About fourteen hours after taking the poison, I found him quite well, though weak. He gave the following distinct account of the attempt of the night before:—He was suddenly tempted, as he said, by the devil to take prussic acid, under a confused idea that it would not hurt him. He swallowed a mouthful of the acid from the bottle in bed. He then got out of bed, walked round the foot of it to a chest of drawers standing within a few yards of the bedside, placed the stopper so firmly in the bottle that it could not be removed, and then walked back to bed, intending to get in again, but sat down on it, and then lost all consciousness. During all this time he had no giddiness, nor unpleasant sensation of any kind, no more than if he had taken so much water. He also assured me, and his manner made me quite confident that he spoke the truth, that the idea of suicide had never before entered his head. The father of the lad afterwards told me that the fæces, and, as he believes, the urine too, were expelled as the first effect of the poison.

The bottle which had contained the poison was found quite empty, so that it was not possible to ascertain the strength of the preparation. From the statement of the father and apprentice, that the bottle contained one or two drachms, and that of the lad himself, that he had swallowed a mouthful, it is highly probable that the dose taken would have proved fatal had it not been for the prompt application of the cold affusion, the continued use of ammonia, and the assiduous application of warmth and friction to the surface—remedies obviously indicated by the extreme coldness of the skin, the blueness of the hands and face, the labouring respiration, and the abundant collection of mucus in the air-passages.

This case is a good illustration of the interval of perfect consciousness and complete command of the muscles which may intervene between the swallowing of a large dose of prussic acid and the development of its characteristic effects; and it is a very striking example of a class of cases of suicide in which the impulse to the commission of the act precedes the act itself by a very short interval, and springs up during a temporary excitement of the mind.

Three medico-legal questions which have been raised in cases

of poisoning by prussic acid have still to be considered. To two of these some importance was attached in the case of Sarah Hart, the victim of Tawell. 1. In poisoning by prussic acid, is there any death-cry or scream which would serve to announce the action of the poison? 2. Are convulsions of common or of universal occurrence? 3. Is prussic acid a cumulative poison? 1. In answer to the first question it may be stated that a patient who is conscious of having swallowed the poison may call out for assistance: but the plaintive cry, or scream, sometimes heard in animals, has not yet been recorded in any case of poisoning in man. 2. It is probable that convulsions are not of more frequent occurrence in poisoning by prussic acid than in other forms of sudden death. The expulsion of the urine and fæces, observed in certain cases, was probably accompanied by short convulsions, and in some cases (as in one reported by Mr. Hicks) there have been efforts expressive of intense anxiety and urgent want of breath; but the deliberate movements of the patient, and the calm and easy attitude of the dead body in almost every instance, show that convulsions are either absent altogether or short and transient. 3. The question, is prussic acid a cumulative poison, may be raised when a patient dies while taking a series of medicinal doses of the acid at intervals of a few hours. It is reasonable to suppose that the previous doses have not spent their force upon the body, and that the addition of the last dose determines the fatal result. In the case of so volatile a poison, and one so readily eliminated, it seems highly improbable that a medicinal dose (generally a small fraction of the smallest fatal one), or even a series of such doses, would leave such a residual effect as to prove fatal on the addition of another dose. But doses that exceed the proper medicinal limit may happen to prove fatal, though similar previous ones have appeared to be harmless, in consequence of a change in the state of the body itself; for there is no doubt that the line which divides a harmless from a fatal dose is not very wide. Fortunately this question, so difficult of solution, is not one of great practical importance.

POISONING BY THE CYANIDES.

The cyanides of potassium and of mercury have destroyed life, the latter with symptoms allied to those of poisoning by corrosive sublimate (see p. 502), the former with symptoms of poisoning by the acid itself.

Cyanide of Potassium.—This substance is now largely used in the arts, both in electrotyping and in photography. It is used

to remove stains of nitrate of silver from the hands, and to clean tarnished metal and gold and silver lace.

Properties.—This salt is sold as a deliquescent white crystal or crystalline mass, having a strong odour of prussic acid, and a characteristic cold, bitter, pungent taste. It is very soluble in water; and the solution has a strong alkaline reaction.

Tests:—*a.* On adding an acid, the vapour of prussic acid is given off, which may be identified by its odour, and by the tests described at p. 605. *b.* It yields with a solution of nitrate of silver the white cyanide. *c.* Chloride of platinum throws down the base. *d.* The liquid tests produce with the solution the reactions described at p. 604; but as the solution already contains potash, the addition of liquor potassæ is not needed.

In *organic liquids* the poison may be detected by neutralizing the base with sulphuric acid, and distilling over the prussic acid.

Symptoms.—This substance acts nearly with the rapidity and violence of prussic acid itself, and gives rise to the same symptoms.

Fatal Dose.—Less than five grains. As the cyanide contains nearly 40 per cent. of the anhydrous acid, it is probable that about two and a half grains would destroy life.

Post-mortem Appearances.—Those proper to poisoning by prussic acid.

Treatment.—That of poisoning by prussic acid itself. As the cyanide is a strong irritant, it should be used with caution whether to remove stains, or for manufacturing purposes.

VEGETABLE SUBSTANCES AND PRODUCTS CONTAINING, OR YIELDING, HYDROCYANIC ACID.

The leaves, seeds, or roots of several plants contain prussic acid, or yield it when bruised and moistened. It is found in the bitter almond, the kernels of the cherry, plum, and peach, and the pips of the apple. The poison is extracted from the leaves of the cherry laurel by distillation, and the plant which yields tapioca (the *Iatropha manihot*, or cassava) contains it in the juice of the root. The bitter almond, the oil and water obtained from it, and the water distilled from the cherry laurel, deserve special notice.

The bitter almond is distinguished, as its name implies, by its bitter taste. It forms with water a white emulsion, in which the essential oil blended with prussic acid is rapidly developed by the mutual action of two of its constituents, *emulsine* and *amygdaline*. The vapour from the emulsion acts characteristically with the tests for prussic acid. As the same change takes place in the

stomach, bitter almonds cannot be safely eaten nor the *bitter almond cake*, which remains after the expression of the fixed oil. This oil, its alcoholic solution (almond flavouring), and bitter almond water, are active poisons, and have proved fatal. Of these three preparations the first is by far the most important, as it is a very active, and a very favourite, poison.

Essence or *Oil of Bitter Almonds.*—This is the product of the distillation of the pulp or emulsion of the bitter almond. It contains, in addition to hydrocyanic acid, hydride of benzole, benzoin, and benzoic acid. The acid, to which it chiefly owes its poisonous properties, may be separated from it, and the essence thus purified, and rendered comparatively harmless, is sold for culinary purposes. The essence, or oil, previous to this separation, contains from $8\frac{1}{2}$ to $14\frac{1}{2}$ per cent. of the anhydrous acid. It is, therefore, from four to seven times as strong as the acid of the Pharmacopœia. A liquid variously known as almond flavour, spirit of almonds, or essence of peach kernels, consists of the oil dissolved in seven or eight times its quantity of spirit.

Properties.—Ordinary specimens of the oil have the colour of amber, a peculiar, pungent odour, due in part to the prussic acid which it contains, and a bitter, aromatic taste. It is heavier than water, which dissolves only a small fraction of it; but it is soluble in alcohol and ether. It produces a greasy stain on paper, and has a slight acid reaction. Strong sulphuric acid reddens it.

Tests.—Those of hydrocyanic acid. Pour drops of the oil into a series of watch-glasses, add a few drops of distilled water, and invert over them disks of glass moistened with the several tests (p. 605). Or, place a few drops of the oil in a test-tube, add a drachm of distilled water, mix well by shaking; pour the mixture on a wet filter, and test the liquid that passes through for dilute hydrocyanic acid.

Symptoms.—Those of poisoning by hydrocyanic acid (p. 609); but the symptoms begin later, and last longer; present similar variety; and similar acts of volition occupy the interval between swallowing the poison and the commencement of the symptoms.

Post-mortem Appearances.—Those of poisoning by prussic acid (p. 610), the odour of the oil taking the place of that of the acid.

Treatment.—That of poisoning by hydrocyanic acid (p. 611).

Fatal Dose.—About twenty drops. As strong specimens of the oil have from four to seven times the strength of the acid of the Pharmacopœia, and a less quantity of the acid than fifty minims has proved fatal, it is probable that ten or twelve drops might kill an adult

Duration.—From a few minutes to half an hour. It may destroy life as speedily as prussic acid itself.

Bitter Almond Water.—This is distilled from the cake left after expressing the fixed oil. It is found in the shops of variable strength, from a quarter per cent. to one per cent., and should never be used as a medicine. It owes its poisonous property to the prussic acid it contains; and responds to the tests for that poison (p. 604). The symptoms, post-mortem appearances, and treatment are those of poisoning by the acid (p. 609).

Laurel Water.—The leaves of the cherry laurel (*prunus laurocerasus*), fig. 158, yield both a distilled water and an essential oil, which have the same properties as the water and oil of bitter almonds, and were formerly employed for the same purposes. The quantity of prussic acid in the water is about a quarter, and in the oil three and a quarter, per cent. Other portions of the plant also yield the poison; but it is not contained in the pulp of the fruit. The cherry-laurel water has more than once proved fatal; but the case which possesses the greatest interest is that of Sir Theodosius Boughton, poisoned by Captain Donellan in 1781.

Fig. 158.

Sir Theodosius Boughton, a healthy young man twenty years old, was in the habit of taking a laxative draught from the hands of his mother. On the morning of his death she observed, while giving him his draught, that it had a strong smell of bitter almonds. "Two minutes after he took it she observed a rattling or gurgling in his stomach; in ten minutes more he seemed inclined to doze, and in five minutes afterwards she found him quite insensible, with the eyes fixed upwards, the teeth locked, froth running out of his mouth, and a great heaving at his stomach, and gurgling in his throat. He died within half an hour after swallowing the draught." The body was carelessly inspected ten days after death, but the post-mortem appearances

ow no light on the cause of death. The odour of the draught, rapid occurrence of symptoms so closely resembling those ent in recorded cases of poisoning by prussic acid, and the dy death of the sufferer at an age when apoplexy is so rare, bine to leave no reasonable doubt of the real cause of death.

II. OXALIC ACID (*Acid of Sugar*).

This substance, under the name of acid of sugar, is largely l by bookbinders, shoemakers, and workers in leather, by w-bonnet makers and workers in straw; and by workers in s; also to take ink-stains out of linen. It is sold both by ggists and by persons who supply the trades using it. Its apness (2*d.* per ounce), common employment, and known vity, commend it to the suicide; its resemblance to Epsom salts ls to accidents; but its sharp sour taste unfits it for the pur- of the murderer, unless mixed with some strongly-flavoured or, such as gin, brandy, rum, porter, or strong tea or coffee.

Oxalic acid takes the sixth place among the poisons. In the years, 1852–56, it was credited with 13 deaths per annum, or at 1 in 21 of the ascertained poisons. Of these 13 deaths, 4 urred in men and 9 in women, and 10 of the 13 were suicidal s.

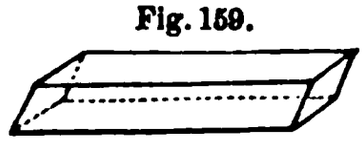
Oxalic acid may have to be examined in *substance*, in *solution*, in *organic mixtures*.

1. *In Substance.*

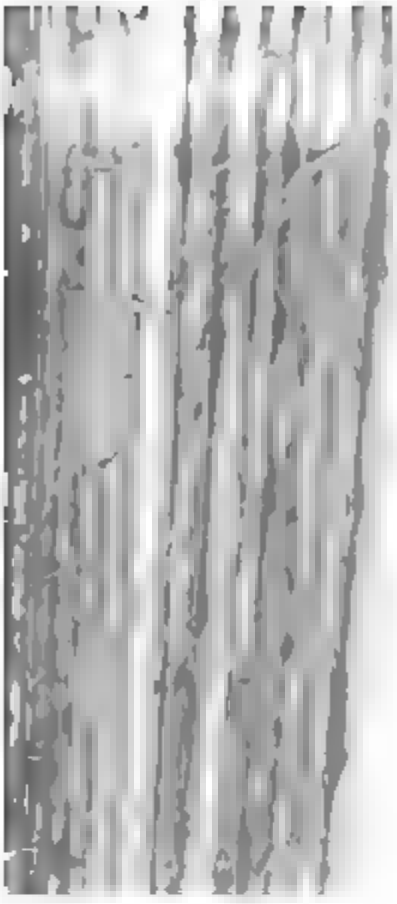
The crystals are transparent, colourless or nearly so, not deliscent, very sour in taste, soluble in their own weight of hot, in about eight times their weight of cold water; also in hol. When heated on platinum foil, they are wholly dis- ted. When heated on a plate of white porcelain, they yield hite sublimate at 180°, and melt at 280° Fahr.

They are flattened four-sided prisms, with dihedral or tetra- ral summits (fig. 159); and, when deposited from solutions of acid, have the forms shown in fig. . They resemble the crystals of sul- te of magnesia and sulphate of zinc, so to be occasionally confounded with m. But they are easily distin- shed.

Fig. 159.



Oxalic acid has a sharp sour taste; the two salts are bitter: solution of oxalic acid has a strong acid reaction; that of sul- te of magnesia is neutral, and that of sulphate of zinc slightly l: oxalic acid is entirely dissipated by heat, or, if impure, leaves



Solution 186.

The liquid is known
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of silver throws down
solutions, produces cha
ammonia. The charac
fully identified are the
1. *Nitrate of Silver.*
oxalate of silver, soluble
dried and heated on pla
a white vapour of finely
2. *Sulphate of Lime.*
oxalic acid a white preci
acids, but insoluble in th
Sulphate of copper y

cipitate ceases to be formed. This, the oxalate of lead, is then diffused through distilled water, and sulphuretted hydrogen gas transmitted through it for two hours. Black sulphide of lead is thrown down, which, being separated by filtration, the acid remains in solution.

If the carbonate of lime or magnesia had been given as an antidote, a modified process will be required to detach the acid from the base. The solid matters must first be broken down, and brought to the consistence of a thin syrup by the addition, if necessary, of distilled water. About a twentieth part of its bulk of carbonate of potash must then be added, and it must be boiled for two hours. The resulting liquid will contain soluble oxalate of potash, and insoluble carbonate of lime or of magnesia, which being separated by filtration, the liquid that passes the filter will consist of oxalate of potash in solution. The base is now to be neutralized with pure nitric acid, and the solution of acetate of lead to be added as long as any oxalate of lead falls. This being collected, and suspended in distilled water, is to be treated by sulphuretted hydrogen, the sulphide of lead filtered off, and the acid solution tested for oxalic acid.

If the antidotes have only partially neutralized the poison, so that the liquid has an acid reaction, the first process must be adopted for the liquid portion, the second for the solid matters.

As oxalate of lime exists in large proportion, but in small absolute quantity, in rhubarb, it is always possible to attribute its detection, when in small quantity, to rhubarb taken medicinally. The history of the case, with the previous symptoms and post-mortem appearances, will meet this objection.

A strong solution of oxalic acid stains black cloth a deep-brown colour without corroding it, it reddens the vegetable blues, and as it removes the colour of ink, it has been used to discharge writing.

Quantitative Analysis.—Use for this purpose the oxalate of lead. 100 grains correspond to 42 of the crystallized acid.

Experiments on Animals.—Large doses (such as ʒss) in strong solution cause symptoms of irritant poisoning, and death from collapse in from two to twenty minutes. Black extravasated blood is found in the stomach, and there are marks of acute inflammation with hardening or softening of the lining membrane.

The effects of oxalic acid on animals have recently been investigated by Onsum, Cyon, and Hermann. According to the experiments of Cyon, when oxalic acid is injected into the circulation or peritoneal cavity of rabbits, it acts as a cardiac poison. Soon after injection the pulse becomes very weak and frequent, dyspnœa

rapidly comes on, and death with convulsions. After death the heart is found dilated and full of blood. It seems to act on the intra-cardial ganglia (Hermann, 'Experimentelle Toxicologie').

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms in man vary with the dose and the concentration of the poison. When the dose is large, and the solution strong, the symptoms follow immediately on the swallowing. An intensely sour taste is speedily followed by a burning sensation in the pit of the stomach, increased by pressure, with pain and constriction of the throat. Vomiting, sometimes of blood, but generally of a greenish-brown or black grumous matter, soon follows, and, if the patient survive several hours there is purging of a similar matter, sometimes tinged with blood. The remaining symptoms are those of collapse—extreme debility, pale and anxious countenance, cold and clammy skin, small and frequent pulse, and hurried respiration. There are also soreness of the mouth, inflammation and swelling of the tongue, constriction of the throat, painful deglutition, intense thirst, restlessness, difficulty of breathing, and harassing cough. Cramps and numbness of the legs and arms, acute pain in the head and back, delirium and convulsions, are among the nervous symptoms present in certain cases.

These symptoms are subject to many anomalies and exceptions. Even pain and vomiting have been absent, or vomiting has not occurred till emetics were given. A rash has appeared on the skin. In one case, leeches applied to the epigastrium soon fell off dead.

Post-mortem Appearances.—The external appearance of the body is natural, and the countenance pale and composed. The lining membrane of the mouth and fauces is generally white, shrivelled, and easily detached, and a similar appearance extends into the gullet, which is contracted into longitudinal and transverse folds, while the epithelium is detached in small irregular patches, leaving a brown surface beneath. The tube sometimes closely resembles a piece of worm-eaten wood. (See figs. 71 and 72, p. 428.) The stomach contains a dark-brown, or greenish-brown, grumous matter, in appearance nearly resembling *meconium*, which also lines the œsophagus, and extends into the duodenum. In some cases, the lining membrane is quite pale, and free from rugæ; in others it is highly inflamed, and the rugæ strongly marked. It is easily stripped off, and in some instances has been extensively detached. Its vessels are minutely injected with black blood. (See fig. 73, p. 428.) Perforation is rare. In

cases of some continuance, the small intestines present the same appearances as the stomach. The peritoneum has been found inflamed, and in one case the right pleura. The lungs are sometimes greatly congested, and in one instance there were some traces of inflammation in the brain.

Occasionally the most characteristic post mortem appearances, like the symptoms during life, are absent.

Of poisoning by oxalic acid, Christison justly observes: "If a person, immediately after swallowing a solution of a crystalline salt, which tasted purely and strongly acid, is attacked with burning in the throat, then with burning in the stomach, vomiting, particularly of bloody matter, imperceptible pulse, and excessive languor, and dies in half an hour, or, still more, in twenty, fifteen, or ten minutes, I do not know any fallacy which can interfere with the conclusion, that oxalic acid was the cause of death. No parallel disease begins so abruptly, and terminates so soon; and no other crystalline poison has the same effect."* The post-mortem appearances are scarcely less characteristic. The wrinkled and corroded gullet, the pale, shrivelled, and partially detached mucous membrane of the stomach, the dark veins ramifying on its surface, and the dark-brown grumous matter which fills its cavity, point strongly to the action of a powerful corrosive poison; while the absence of the coloured spots on the skin precludes the supposition of the effect being due to either of the mineral acids.

First Appearance of Symptoms.—When the quantity of the poison is considerable, and the solution concentrated, the symptoms begin immediately. If the quantity is small, and the solution weak, they may be delayed for some hours.

Fatal Dose.—Less than *half an ounce* has proved fatal (in the case of a lad æt. sixteen, about a drachm); but a smaller quantity has produced severe symptoms, and, on the other hand, recovery has taken place after the administration of two or three times as much.

Fatal Period.—Death may take place in less than *ten minutes*. In one case, the subject of an inquest held by Mr. Wakley, it

* Of 11 cases of poisoning by oxalic acid reported in the Journals, 5 were accidental, and 6 suicidal. Of the accidental cases 3 were by mistake for Epsom salts. Of 13 cases, 6 recovered and 7 died: 3 occurred in males and 10 in females. The duration of the fatal cases was as follows—2 of a quarter of an hour, 1 of twenty minutes, 1 of less than half an hour, and 1 of eight days. The average duration of the first 4 cases was about twenty minutes.

The reader is referred to the following cases: 'Med. Gazette,' i. 757; v. 704; xxvii. 870; xxxi. 491. 'London Medical Repository,' vi. 474; xi. 20; xii. 18. 'Lancet,' Dec. 15, 1827; vol. ix.; x. 512; xxxii. 748; xxxiii. 29. 'Guy's Hospital Reports,' vii. 353. 'Edin. Med. and Surg. Journal,' xxiv. 67.

must have been nearly instantaneous. Life has been prolonged to the twenty-third day, the dose having been half an ounce.

Mortality.—The majority of cases prove fatal. A small number recover under prompt treatment.

Treatment.—The proper antidote is chalk, suspended in water. Magnesia or its carbonate may also be used: in the absence of these the plaster of the apartment. Lime water and oil have been used with advantage; but the alkalies are inadmissible. Warm water may be given freely, after the use of the antidotes. If vomiting is not present, emetics of sulphate of zinc may be employed. The stomach-pump should not be used, or it should be introduced with the greatest caution.

BINOXALATE OF POTASH (*Salt of Sorrel—Essential Salt of Lemons*).

This salt is a constituent of wood-sorrel and of other plants. It is used for bleaching straw and removing ink-stains, for which purpose it, or a quadroxalate of potash, is sold under the name of "essential salt of lemons," for three halfpence the half ounce. As a poison it is nearly as active as oxalic acid. It has been taken by mistake for cream of tartar.

Tests.—The salt consists of colourless rhombic prisms; has a sour taste, and strong acid reaction; and is much less soluble than oxalic acid, requiring forty parts of water for its solution. It resembles oxalic acid in yielding a white precipitate with nitrate of silver and sulphate of lime, and in its reactions with sulphate of copper and the salts of lead.

When the crystals are heated on platinum-foil, they leave a white ash of carbonate of potash, which effervesces with nitric acid, forming nitrate of potash. When they are heated on a slab of porcelain, they sublime at 280° Fahr., and a superimposed disk of glass bears a sublimate of coarse white crystals.

Symptoms.—Those of poisoning by oxalic acid. In a case of recovery after taking a quarter of a teaspoonful of this substance, reported by Dr. F. C. Webb, there was burning in the throat, a red tongue, intense thirst, no abdominal pain, vomiting after the lapse of two hours, severe pain in the loins, dysuria, great weakness of the legs, pain in the head, and cramps in the hands and legs.

Post-mortem Appearances.—As in poisoning by oxalic acid.

Treatment.—That of poisoning by oxalic acid.

Fatal Dose.—Half an ounce.

Fatal Period.—Eight minutes, in a lady recently delivered.

Mortality.—Like oxalic acid, it has proved fatal in the greater number of cases.

TARTARIC ACID has been once or twice taken as a poison.

Tests.—This acid crystallizes in oblique rhombic prisms. It is colourless, and has a pleasant taste; is soluble in five or six times its weight of water, and less soluble in alcohol. When heated, it first fuses, and then burns with a light red flame, giving out a peculiar odour, and leaving an abundant deposit of carbon. It also deposits carbon when heated with strong sulphuric acid.

The solution deposits feathery crystals; yields no distinct precipitate with nitrate of silver; and gives with the salts of potash a white granular precipitate (the bitartrate); aided in dilute solutions by friction of the sides of the vessel with a glass rod.

Experiments on Animals.—These prove that tartaric is much less active than oxalic acid. In full doses it destroys life in less than an hour, with great weakness, and palsy of the limbs.

Symptoms.—One ounce, dissolved in half a pint of warm water, proved fatal to a young man in nine days, with the ordinary symptoms of irritant poisoning. There are no specific symptoms.

Post-mortem Appearances.—In the case just referred to, inflammation of the greater part of the alimentary canal.

Treatment.—By the same antidotes as oxalic acid, with the after-treatment proper to the class of irritants. The soluble salts of potash are not contra-indicated, as in poisoning by oxalic acid.

CITRIC ACID, as shown by experiments on animals, is a more active poison than the tartaric. In a case of poisoning by it, the treatment would be that proper to oxalic or tartaric acid.

III. ACONITE (*Aconitum Napellus, Monkshood, Wolfsbane, Blue-rocket*).

With the exception of the Aconitum ferox, which grows on the Himalayan mountains in India, the Aconitum napellus is the most active poisonous plant of the many that go by the name of *aconite*. Some have no poisonous property whatever. But not only is the Aconitum napellus, with this single exception, the most active poisonous plant bearing the name aconite, it is also, when compared with other poisonous plants, a very fatal one, and there is reason to believe that *aconitina*, the active principle of the plant, is the most deadly poison in existence.

Monkshood belongs to the Linnæan class and order *Polyandria trigynia*, and the natural order *Ranunculaceæ*, or *crowfoots*. It

is a beautiful plant, from two to six feet in height, with dark-green leaves, of very characteristic form, and a terminal spike of rich blue flowers. It grows on hilly ground in many parts of Europe, is supposed to be indigenous, and is often cultivated as a garden flower. Fig. 161 shows a cutting of the plant.

Fig. 161.

All parts of the plant are poisonous, but the root is the most active. Both *root* and *leaves* have been several times taken as poisons; and the *extract* and *tincture* have also proved fatal.

The leaves and root are in the British Pharmacopœia. The fresh leaves and flowering tops yield an *extract* of which the dose is from 1 to 2 grains; and the dried root a *tincture* (2½ ounces to a pint—dose, 5 to 15 minims) and a liniment (1 ounce to a fluid ounce).

The *leaves* are completely divided to the base into five wedge-shaped lobes, which are again divided into three, the segments being linear. They are not to be mistaken for the leaves of any other plant.

The *seeds* are numerous, three-sided, irregularly twisted, and wrinkled, of a black or dark-brown colour, a sixth of an inch long, weighing 25 to the grain. Fig. 162 shows their size and shape, and fig. 163 the markings on their surface, as seen under the microscope. A single seed contains enough of the active principle of the plant to produce numbness and tingling of the lips, tongue, and throat.

Fig. 162.

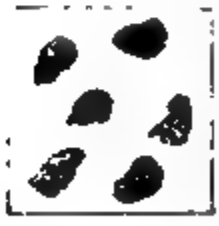


Fig. 163.

The *root* has more than once been scraped and eaten instead of the horse-radish. This accident occurred in 1836 to a Mr. and Mrs. Prescott and their child, whose cases are minutely described by Pereira; in 1842 to a lady residing at Lambeth

(Taylor); in the winter of 1853 to two brothers, of whom one died and the other recovered. Still more recently, in the winter of 1856, the poison killed two priests at Dingwall, and a third person out of five who were affected at a dinner there. In the next year, 1857, a case occurred in London. The recorded cases are now very numerous. The root has also been given intentionally in one instance at least.

It is not easy to understand how the root of monkshood should be mistaken for that of the horse-radish, even if the respective plants were not attached to the roots; for though the section of both roots is white when fresh, the scrapings of monkshood are friable and succulent, those of the horse-radish tough and stringy, and the first soon acquire a pink hue while the second remain white. The two roots differ in shape, colour, and taste. The root of monkshood is conical, and throws off a large number of curling fibres, and it is not unusual to find one or more pear-shaped tubers, attached by narrow necks to the upper part of the root-stock, as in the specimens shown in fig. 164, which, with the single root in fig. 165, were selected out of a large number of fresh roots of Aconitum napellus, as presenting the most characteristic varieties of form. The figures are of the size of the roots themselves; but it must be understood that the single root may attain two or three times the size depicted in fig. 165. On the other hand, the root, or, as it is commonly called, the stick of the horse-radish (fig. 166), is cylindrical in all its larger branches, and throws off straight rootlets. The colour of the monkshood-root is a dark nut-brown externally, that of the horse-radish is buff-coloured. The root of the monkshood when chewed soon causes a peculiar tingling and numbing sensation in the lips, with a feeling of enlargement, and a similar sensation in the throat, when swallowed; and this sensation in the lips and throat continues for several hours: the taste of the horse-radish is pungent and sweet; causing profuse lachrymation, but not being very persistent.

This peculiar numbness and tingling of the lips is produced by the leaves and seeds, and, indeed, by every part of the plant.

Experiments on Animals.—These have been made with monkshood, and its active principle aconitina, by Brodie, Orfila, Christison, and Pereira, and more recently by Drs. Fleming and Headland. According to Dr. Fleming, aconite, when introduced into the system of one of the lower animals, causes, successively, weakness of the limbs and staggering; accelerated, or slow and labouring respiration; paralysis; diminution, or total loss, of sensibility of the surface; dimness of vision, or actual blindness;

increasing difficulty of breathing; and, after a few spasmodic twitches, death by *asphyxia*. On examining the body immediately after death, the heart is found beating with considerable strength, which it continues to do for some time; the peristaltic action of the intestines also continues; the irritability of the voluntary muscles is impaired but not extinguished; there is general venous congestion, with distension of the right side of the heart and large veins, and venous blood is usually found in the left cavities of the heart, and in the aorta. The venous system of the brain is often gorged with blood. Dr. Fleming adds that in some of his experiments there were decided convulsive movements, and, in two instances, distinct opisthotonos; that in general the pupil was more or less *contracted*;* that the pulse became weaker and less frequent; and that the poison did not appear to give rise to any local irritation. From other experiments of Dr. Fleming's it would appear that aconite proves poisonous to vegetables.

Aconite exerts a very decided action on the heart, but some points of difference exist among experimenters as to its exact influence. Apparently there is at first a slight retardation of the heart's action by stimulation of the vagi, followed by increased rapidity with loss of power, ending in complete paralysis in a state of diastole. The paralysis of the heart accounts for the dyspnœa and convulsions which are observed. As regards the action of aconite on the nervous system and the motor and sensory functions, it is stated by some that the effect is primarily on the spinal centres, by others that it is due to direct action on the peripheral sensory and motor nerves. Death is the result of the cardiac paralysis, which may manifest itself as syncope, or with dyspnœa and convulsions.

The *symptoms* of poisoning by monkshood in the human subject are:—numbness, tingling, and burning heat in the mouth, throat, and stomach, followed by nausea and vomiting, with pain and tenderness of the epigastrium. The numbness and tingling speedily become general, with diminished sensibility of the surface, vertigo, dimness of vision, or complete blindness, tinnitus aurium, and occasionally deafness; frothing at the mouth; sense of constriction in the throat, with sensations of weight and enlargement of various parts of the body, but especially of the face and ears; great muscular feebleness, with general tremor; more

* This statement is opposed to Dr. Headland's experience. He found that it caused in animals dilatation of the pupil, but in a less degree than belladonna. ('Lancet,' March 29, 1856.) Recent experimenters also describe the pupil as being *dilated*.

Fig. 164.

Fig. 165.

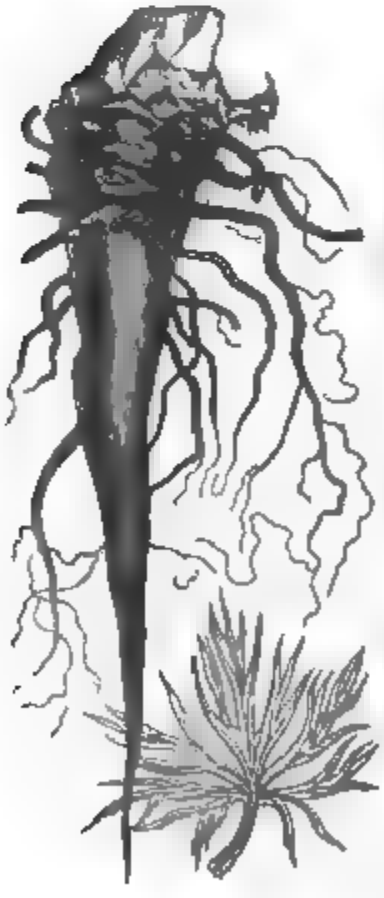
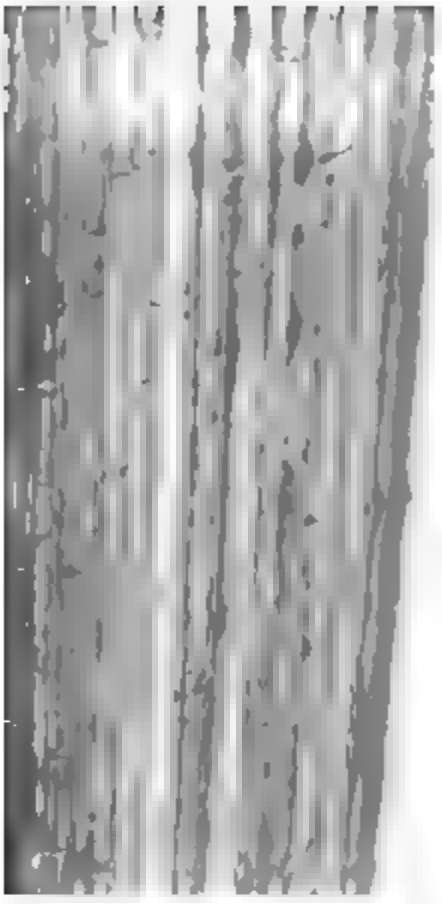


Fig. 166.



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and brandy (twice repeated within an hour), complete recovery took place. This case affords good reason for the future employment of digitalis in poisoning by aconite.

Diagnosis.—In some instances we are able to identify portions of the plant itself in the alimentary canal. An alcoholic extract of the contents of the stomach, applied to the lips, produces the peculiar numbness and tingling already described, and if given to some small animal would be identified by its fatal effects.

ACONITINE.—This alkaloid is so active a poison that, according to Headland's experiments $\frac{1}{300}$ of a grain will kill a mouse; $\frac{1}{100}$, a small bird in a few minutes, and $\frac{1}{50}$ almost instantaneously; $\frac{1}{20}$ of a grain a cat, and $\frac{1}{10}$ of a grain the same animal in twenty minutes or half an hour. Dr. Headland is of opinion that $\frac{1}{10}$ of a grain would kill an adult man, and Dr. Herapath performed an analysis in a case at Bristol, from which he inferred that $\frac{1}{20}$ of a grain had proved fatal. $\frac{1}{1000}$ of a grain causes tingling and numbness of the tip of the tongue, and $\frac{1}{100}$ of a grain dissolved in spirit, and rubbed into the skin, causes loss of feeling, lasting for some time. Aconitina may be separated from organic liquids by the method of Stas, or by a similar method suggested by Dr. Headland. In the fresh root, the alkaloid is contained in the proportion of a quarter to three-quarters of a grain in the ounce, and in the dried root, of twelve to thirty-six grains to the pound.

Properties.—Aconitine is generally sold as a white amorphous powder; but it may be obtained in small crystalline masses, or even in well-formed colourless crystals. It belongs to the group of alkaloids which are not changed in colour by cold sulphuric acid; but it is characterized by assuming a deep brown tint when *warmed*. Nitric acid dissolves it without change of colour.

When heated on porcelain, it readily melts into a yellow liquid, gives off a light vapour, and spreads into an abundant carbonaceous layer. When heated in the manner described at p. 407, it melts at the characteristically low temperature of 140° Fahr., and at 400° yields sublimates which are not crystalline.

The alkaloid is moderately soluble in water, and has a strong alkaline reaction. It is soluble in alcohol, ether, and benzole, and very soluble in chloroform. It is also soluble in acids, but its salts are not crystalline. It has the taste, and produces the peculiar impression on the lips, tongue, and palate described above.

Tests.—*a.* The peculiar effect on the lips, tongue, and palate. *b.* The reaction with sulphuric acid. *c.* The absence of change with nitric acid. *d.* The low temperature at which it melts, and the high temperature at which it sublimes, with the unpronounced character of the sublimate. *e.* The absence of precipitate with iodide of potassium and bichloride of platinum.

IV. VERATRUM ALBUM (*White Hellebore*).—VERATRIA.

The *veratrum album*, or white hellebore (natural order Melanthaceæ) is not an indigenous plant, but grows abundantly in the mountain districts of the Continent. (Fig. 167.) Every

Fig. 167.

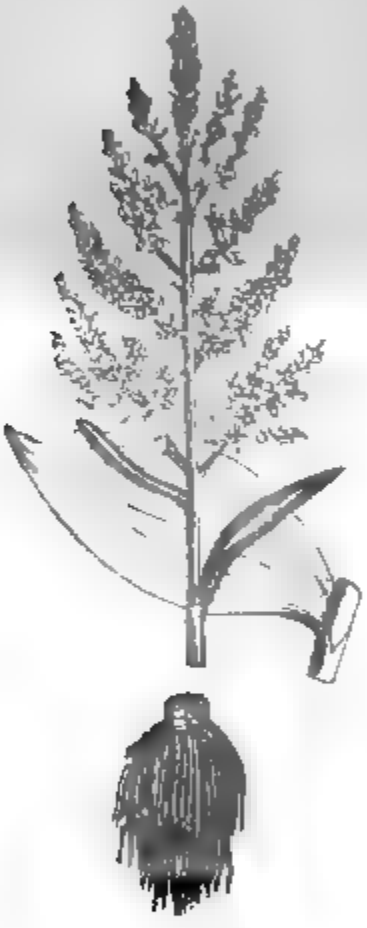


Fig. 168.

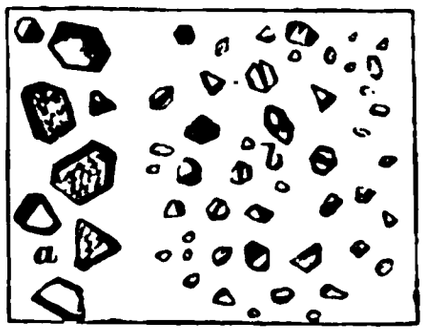
part of it is poisonous; but the powdered root, or an infusion from it, has been most commonly taken as a poison. The powder has nearly the colour of powdered jalap, has an acrid, bitter taste, and strongly irritates the nostrils. Hence its use, mixed with starch, as an errhine; but its principal use is to destroy vermin on the skin or hair.

The plant owes its activity to the alkaloid *veratria*. Veratria is also found in the cebadilla (the fruit of the *Asagræa officinalis*).

VERATRIA (*Veratrine*).—This alkaloid is prepared from the cebadilla (British Pharm., p. 365), and is the active ingredient in

the unguentum veratriæ (8 grains to 1 ounce). When pure it is a white amorphous powder, without odour, but highly irritating to the nostrils, and of an intensely bitter and highly acrid taste. It is insoluble in water; but more or less readily dissolved by alcohol, ether, chloroform, benzole, and fusel oil. It has a slightly alkaline reaction, and forms soluble salts with the acids. Strong sulphuric acid first turns it yellow, then a rich crimson, the change taking place instantaneously when the acid is gently heated. When heated on a porcelain slab it darkens, melts readily into a yellow liquid, blackens, and spreads into an abundant carbonaceous layer. The vapour has a disagreeable pungent odour; and, when received on a clean disk, deposits detached crystalloids, or crystals described as rhomboidal, but among which several octahedra can be discovered. These crystals, in two degrees of enlargement, are shown in fig. 169. When heated on platinum-foil, the alkaloid is entirely consumed.

Fig. 169.



The symptoms of poisoning by veratrum album and veratria are in all respects similar.

Symptoms.—Locally applied the powder and alkaloid irritate the mucous membranes of the nose and mouth, causing violent sneezing and salivation. When swallowed they cause a burning sensation in the stomach, with nausea, vomiting, and diarrhœa. The constitutional effects are a remarkable depression of the heart's action, the pulse becomes imperceptible, the skin pale and cold, and death takes place usually in a state of insensibility with convulsions.

Experiments on Animals.—Two grains of veratria in solution given to a cat, began to act immediately, causing frothing at the mouth and collapse, and death in less than a minute. Three grains given to a young dog, caused immediate and repeated vomiting, involuntary discharge of urine, great prostration, and death in two hours.

The effect of veratria on the heart and circulation is apparently a constant phenomenon in all animals. It lowers the pulse and energy of the heart. In the frog, the heart is brought to a standstill in a state of paralysis, and is no longer capable of being excited by galvanic stimulation. The influence on the heart is complex, being partly due to its action on the cardiac nervous apparatus, and partly to a direct action on the muscular tissue of the heart itself.

Post-mortem Appearances.—Marks of acute inflammation in the alimentary canal.

Treatment.—The prompt use of the stomach-pump, or, in the absence of vomiting, emetics of sulphate of zinc. Vegetable infusions containing tannin, as an antidote, or finely-divided charcoal. The collapse to be met by diffusible stimulants and by opium, which seems to have been useful in some cases.

Fatal Dose.—A fraction of a grain. A sixteenth of a grain has produced a state of dangerous collapse. (Taylor.)

Fatal Period.—It may be inferred from experiments on animals, that death would happen speedily.

The *veratrum viride*, or green hellebore (fig. 168), possesses poisonous properties resembling those of the veratrum album. It furnishes to the British Pharmacopœia a tincture of which the dose is from 5 to 20 minims. It appears also to be a poison in common use in North America, where it is known as "Indian poke." It produces in poisonous doses the same depressing effect on the heart and circulation, and may cause death from fatal collapse. It is said to be less irritating to the alimentary canal.

Bullock has obtained from it two alkaloids, *viridia* and *veratroidia*, the action of which has been experimentally investigated on animals by Wood ('Amer. Journ. of Med. Sc.' cxvii). Both act on the heart, but veratroidia appears to have a more marked irritant action than viridia.

V. DIGITALIS (*Digitalis purpurea*—*Foxglove, purple Foxglove*).

Fig. 170.

This is an indigenous plant, common about banks and hedgerows, and in pastures, on a gravelly or sandy soil. It is also cultivated for its elegant shape and purple dotted flowers (fig. 170).

It belongs to the Linnæan class and order *Didynamia angiospermia*, and natural order *Scrophulariaceæ*, or figworts.

All parts of the plant are believed to be poisonous, and the leaves have more than once destroyed life.

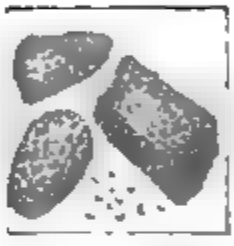
It owes its poisonous property to the alkaloid *digitaline*, which exists in the fresh leaves in the proportion of less than one per cent. The dried leaves have a place in the British Pharmacopœia; and yield an infusion (30 grains to 10 ounces; dose, two to four

drachms) and a tincture (two ounces and a half to a pint; dose, ten to thirty minims).

The *root* consists of numerous long slender fibres, and is not likely to be confounded with any of the common edible roots.

The *leaves* are ovate, narrowed at the base, crenate, rugous, and veined, downy, especially on the under surface. The dried leaves have a dull green colour, a faint odour, and a bitter, nauseous taste.

Fig. 171.



The *seeds* are of the small size shown in fig. 171, and weigh about 1126 to a grain. They are of a light brown colour, cylindrical, ovoid, or conical in shape, and, when viewed by the lens or microscope, present a pitted appearance. They resemble the seeds of the Lobelia inflata in colour, but are somewhat larger, and differ widely in microscopic character.

Experiments on Animals.—In moderate doses digitalis causes vomiting, giddiness, languor, and death in twenty-four hours. In larger doses, in addition to these symptoms, tremors, convulsions, stupor, and coma. Injected into the veins, it kills in a few seconds, by acting on the heart and pulmonary circulation. In one of Mr. Blake's experiments, an infusion of three drachms of the leaves injected into the jugular vein arrested the action of the heart in five seconds, that organ after death being motionless, turgid, inirritable, and its left cavities full of florid blood.

Symptoms.—In the human subject, a single fatal dose occasions —Vomiting, purging, and severe colicky pains; pain in the head, giddiness, and dimness of vision, or actual blindness; a dilated and insensible pupil; a slow, weak, and irregular, or intermittent pulse; nausea and faintness, with occasional syncope; the skin covered with a cold perspiration; the patient is much worse when he assumes the upright posture. Salivation is a common occurrence. The urine is suppressed; convulsions occasionally occur; and the patient sometimes continues for a long time in a state of stupor. In two fatal cases death took place in twenty-two hours. When the poison is not fatal, the recovery occupies several days, and the circulation is slowly restored to its normal state.

The *post-mortem appearances* are turgescence of the vessels of the brain, and redness of the membrane of the stomach.

Occasionally, in the practice of medicine, serious symptoms show themselves, without terminating fatally. There are dryness in the throat, and thirst; nausea; headache; salivation; giddiness, and dimness of sight, an appearance of sparks before the

eyes, and a feeling of pressure on the eyeballs; with weakness of the limbs, and a weak and rapid pulse.

The symptoms arising from the gradual accumulation of the poison are nausea, dryness of the mouth, loss of appetite, vomiting, and intense thirst; giddiness, and throbbing of the temples; restlessness and sleeplessness; a hot and moist skin; great languor and depression, with, in most cases, a slow pulse. Diarrhœa, salivation, an increased flow of urine, delirium, spectral illusions, convulsions, and coma, are occasional symptoms.

Fatal Dose.—This has not been ascertained. No poison in common use is of more uncertain operation; and in the treatment of inflammatory diseases, as well as in delirium tremens, it is often administered in doses which would be very unsafe in a state of health. Pereira cites several cases, both in children and adults, in which the tincture of digitalis was given in such doses as twenty drops three times a day to an infant, and from half an ounce to an ounce to an adult; but in these cases the natural operation of the poison was counteracted by disease accompanied by decided febrile action, or by intoxication attended by great excitement of the circulation.

The *treatment* will consist in the use of emetics, followed by aperients, and by the free use of vegetable infusions containing tannin, such as infusions of nutgalls, or of oak-bark. These are given with a view of rendering the alkaloid *digitalia* inert. Green tea or strong coffee may also be given with advantage. Stimulants, such as ammonia, wine, and brandy, should also be administered, and the recumbent posture be strictly preserved. Friction to the spine, though less indicated than in poisoning by aconite, or when asphyxia is imminent, might be used with advantage; and, in desperate cases, artificial respiration, and galvanic shocks through the heart.

DIGITALIA (*digitaline*).—*Properties.*—When pure, this alkaloid is white and amorphous; when less pure, of a light yellow or brown colour. It belongs to the group of alkaloids which is changed in colour by cold sulphuric acid. The colour is a red-brown, which deepens when the acid is warmed, and still more when heated. Its colour is not changed by nitric acid.

When heated on porcelain, it darkens, melts slowly into a brown liquid, yields an abundant thick vapour, and swells into a bulky black ash. The vapour has the odour of the drug. When heated in the manner described at p. 407, it melts and sublimes at 310° Fahr. The sublimate is not characteristic.

Digitaline is sparingly soluble in cold or hot water, and has an

intensely bitter taste. It does not form crystallizable salts with acids; and is soluble in alcohol, and in benzole.

Tests.—*a.* The effect of sulphuric acid just described. *b.* The negative effect of nitric acid. *c.* On adding a solution of bichromate of potash to the recent solution in sulphuric acid, the liquid becomes first yellow, then green. *d.* Hydrochloric acid turns it yellow, changing quickly to green. *e.* Its solution evaporated to dryness, and treated with sulphuric acid, yields a rose colour, changed to *mauve* on exposure to bromine gas.

Experiments on Animals.—Digitaline acts specially on the heart and vascular system. The heart's action is at first strengthened and the pulse retarded, while the blood pressure is raised by contraction of the blood-vessels. Later a paralytic condition both of the heart and blood-vessels ensues. In very large doses paralysis of the heart's action comes on rapidly without a previous stage of stimulation.

The interesting experiments of Drs. Fagge and Stevenson* have shown that the substance shares with the veratrum viride, squill, and one or two other poisons, the power of acting on the frog's heart in a characteristic manner, causing a peculiar form of irregularity in its beats, the stoppage of the ventricle in the white, contracted state, and the retention of the voluntary power when the heart stops, and for at least 15 to 20 minutes afterwards.

The quantity of the alkaloid in the leaves is less than one per cent.; and it is believed that a dose of $\frac{1}{16}$ grain would produce symptoms of poisoning in an adult.

Symptoms in Man.—One celebrated case of poisoning by digitaline is on record; namely, that of the woman Pauw, poisoned by Dr. De la Pommerais in 1864. The symptoms agreed with those given above; and MM. Tardieu and Roussin, who investigated the case, arrived at the conclusion that digitaline was the poison employed.

* 'On the Application of Physiological Tests for certain Organic Poisons, and especially Digitaline:' Guy's Hospital Reports, 3rd Series, vol. xii. p. 37.

CHAPTER XV.

ASPHYXIANTS.

1. Carbonic acid, Carbonic oxide, and the products of combustion.
2. Sulphuretted hydrogen, and the gaseous contents of sewers and drains.
3. Carburetted hydrogen and coal gas.
4. Nitrous oxide.

The term "*asphyxiants*," placed at the head of this chapter, is used in the same sense as the words "narcotics," "deliriants," "inebriants," which distinguish other chapters. The gases are poisonous agents applied to the air-passages, and causing suffocation as a leading and conspicuous symptom, but, at the same time, giving rise to headache, giddiness, drowsiness, insensibility, and failure of muscular power, and, in exceptional cases, to spectral illusions, delirium, and maniacal violence, showing their direct action on the nervous system. In a state of concentration these gases may cause spasm of the glottis, and consequent death by suffocation; but, as usually inspired, they are largely diluted with atmospheric air, and not uncommonly mixed with other purely irritant or otherwise deleterious gases.

I. CARBONIC ACID GAS.

Carbonic acid gas is generated in many different ways. It is the principal product of the combustion of fuel; is given out largely in the process of fermentation, and in the burning of lime; animals expire it, and plants exhale it freely at night; and it collects in mines, caves, coal-pits, graves, and wells. The gas produced in any of these ways may give rise to fatal accidents.

The question of accident, suicide, or homicide, is rarely raised in poisoning by this gas. The place in which a body is found, and the surrounding circumstances, are generally decisive as to the cause, which, in this country, is commonly accidental. Suicides rarely resort to it, though the practice is very common in France; and it is not a likely instrument of murder, though

some cases related by Devergie seem to justify the suspicion that it has been so employed.

But thongh the cause of death in poisoning by carbonic acid will generally be inferred from the place and circumstances in which a body is found, suspicions of foul play have been ignorantly entertained; and the dangerous or fatal results have been attributed to mechanical suffocation (Reports of Ambrose Paré), or to some poison administered by the mouth (Christison).

Occasionally the true state of things is not suspected till several persons have suffered or perished; as when the woodwork of houses is carbonized by heated flues, or the products of combustion make their way from one apartment to another.

Properties.—A colourless gas, inodorous, but pungent to the nostrils. It is much heavier than atmospheric air, with which it mixes slowly. It is soluble in water, has the reaction and other properties of an acid, and combines with lime to form chalk.

Tests.—*a.* It produces a milkiness, followed by a white precipitate, in lime water. *b.* It does not support combustion; and when mixed with air, in the proportion of from ten or twelve to fifteen or twenty per cent., extinguishes flame. For a small flame as little as ten or twelve per cent. will suffice. *c.* Litmus paper moistened with bleaching liquid is first reddened, and then bleached by the gas as it exists in the air. A jet of carbonic acid is easily recognised by its pungent effect on the nostrils.

The property of combining with lime is turned to practical account in purifying the air of wells or pits. A vessel of lime, mixed up with water into a thin paste, is lowered into the stratum of gas. The same result may be obtained by a current of air or jet of steam.

Quantitative Analysis.—The quantity of carbonic acid in the air may be determined by the amount of absorption that takes place in a graduated jar containing liquor potassæ. The gas may be collected for analysis by emptying a full jar of water into the space containing it. The quantity of charcoal that has been burned in any case may be estimated at from twenty to twenty-five times the weight of ash.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Carbonic acid gas, pure and unmixed, acts as an irritant, causing spasm of the glottis, and death by apnœa. In a state of dilution, whether pure or mixed with other products of combustion, it may be breathed for a considerable period; the symptoms varying in intensity with the quantity of the gas, and in character with the gases that happen to be mixed with it. The

more active carbonic oxide intensifies the narcotic symptoms; the sulphurous acid gas given off during the combustion of coal irritates the organs of respiration; and other modifications may arise from the admixture of carburetted hydrogen, or of other hydrocarbons.

The usual symptoms of poisoning by carbonic acid are:—a sense of weight in the forehead and occiput, and of tightness in the temples, violent headache, giddiness, ringing in the ears, dimness of sight, drowsiness; hurried respiration, and violent palpitation; nausea, and, in many cases, vomiting; followed by complete insensibility, stertorous breathing, slow pulse, pallor and lividity of the surface; and death from apoplexy, or from spasm: or as the sequel of a deep sleep, as in drowning and hanging. Pleasurable sensations; early delirium; and convulsions and tetanic spasms are among the occasional symptoms.

An instructive case of recovery showing the effects of the gas on the nervous system, is related by Sir George Baker, on the authority of Heberden. A young man was shut up in the morning in a close room with burning charcoal till two small birds fell down dead in their cages, when he felt so ill as to be obliged to go into the open air. This he had no sooner done, than he fell down senseless. When he came to himself, he complained of giddiness, sickness, pain in his stomach and loins, and stupor, lasting the whole day. Next day he felt better, but about 7 P.M. was seized with violent pain of the stomach and loins, vomited, threw himself on the ground, fell into convulsions, and could hardly fetch his breath. Soon after, having somewhat recovered, he had a second fit of the same kind. About an hour afterwards he became delirious, and was with difficulty kept in bed during the night. In the morning he came to himself, and had some quiet sleep; but the pain was not quite gone, and giddiness, with strange sights before the eyes, continued for some little time longer.*

Post-mortem Appearances.—The body is generally swollen, the skin marked more or less extensively with livid spots, the limbs often rigid, and the abdomen distended with air. The face is, in some cases, pale and composed, in others livid and bloated; and the eyes are bright and prominent. Froth, or froth tinged with blood, is sometimes found about the mouth and nostrils; and the tongue is often protruded and grasped by the teeth.

* An account of a singular disease which prevailed among some poor children, maintained by the parish of St. James, in Westminster, in the 'Medical Tracts,' by Sir George Baker, Bart., M.D., F.A.S., collected and republished by his son (1818), p. 616. For an abstract of this instructive case consult Dr. Guy's 'Public Health,' p. 12.

The animal heat is retained longer than usual, cadaverous rigidity is slow to show itself, and putrefaction is retarded. The internal appearances are as follows:—the large veins and right cavities of the heart gorged with black blood, and the lungs and lining membrane of the air-passages congested. The base of the tongue is injected, and ecchymosed patches are sometimes found in the alimentary canal. The abdominal viscera (and notably the kidneys) and the ascending cava are also greatly congested. The brain and its membranes are injected, the veins and sinuses distended, and serum is found in the ventricles, and at the base; and there may be effusions of blood on the surface of the brain or into the ventricles.

Some of these appearances bear a close resemblance to those present in death by apnœa; but the turgescence of the brain is much more remarkable, and it has been proved experimentally that the gas does not act merely as an asphyxiating agent, but as a specific narcotic poison.*

Treatment.—This consists in prompt removal to a pure air, the use of cold affusion as a shock, and, when the face is bloated and livid, of blood-letting. Friction and warmth to the surface are indicated, as in cases of apnœa. Artificial respiration, galvanism, and the inhalation of oxygen gas may be resorted to in extreme cases.

Preventive Measures.—The prevention of accidental poisoning by carbonic acid must rest in a great degree on the possession by the public of correct information respecting combustion and its

* As the value of some of the post-mortem appearances was a subject of lively controversy in the case of James Trickey, given in the text, the following particulars are subjoined from a paper by Dr. Golding Bird: 'Guy's Hospital Reports,' vol. viii. p. 75.

The *expression of countenance* was noted in 12 cases: it was pale and calm in 5; bloated in 7. *Vomiting* had occurred in three cases, and was absent in 5 in which the symptom was noticed. There was *froth at the mouth* in 6 cases; it was absent in 4. There was *froth and serum* at the nostrils in 4, and they were lined with black mucus in 2. The *eyes* were injected in 2; dilated, prominent, and shining in 3; closed and dull in 3. The *limbs* were rigid in 5; flexible in 2. The *tongue* was protruded and grasped by the teeth in 6; drawn in and concealed in 2. There were livid patches on the skin in 10 cases; they were absent in 2. The *abdomen* was distended in 9; not distended in 4. The *membranes of the brain* were injected with blood in 8, and described as congested in 4; there was *serous effusion* beneath the arachnoid in 3, no effusion on the brain in 6; and *serous effusions* in 3. The *vessels and sinuses* were turgid in all the cases in which those parts are mentioned. The substance of the brain was injected in 8. Blood was effused on the surface in 1. Serum in the *ventricles of the brain* in 6; absent in 3. Blood was effused into them in one case; the brain was in its natural condition in two cases. The blood throughout the body was not always of the same colour.

Devergie lays great stress on the rosy or livid discoloration of the skin, and on the persistence of animal heat and rigidity, and the slow march of putrefaction, in these cases. ('Annales d'Hygiène,' vol. xvii. p. 225.)

products, and of the situations in which the gas is most likely to collect. The fact that stoves heated by charcoal, and giving off carbonic acid into the open air of rooms, are used by persons of education, shows how little scientific knowledge they may possess. But even intelligent and educated persons do not always understand that a candle may burn in an atmosphere which will speedily prove fatal to life; while, on the other hand, a man may for a short time breathe with impunity air in which candles are extinguished. Thus, Mr. Coathupe cites the case of a man who descended into an abandoned coal-pit, in which lighted candles were repeatedly extinguished, remained in it for several minutes, and succeeded in recovering the body of a child, who had fallen from a part of the old machinery. Again, in a case mentioned by M. Marye, and quoted by Devergie, a candle was extinguished in an atmosphere that produced only a slight sensation of uneasiness in a gentleman who made an abortive attempt at suicide; while in another and successful attempt, a candle was found burning on the table, whilst the man was lying dead on the floor. In the former instance, the candle was probably below the level of the body, in the latter, above it.*

There are several interesting and practically important questions connected with poisoning by carbonic acid, some of which are set forth in the following case, which, at the time of its occurrence, excited a lively interest, and gave rise to much discussion.

James Trickey, aged 66, watchman and steeple-keeper of St. Michael's Church, Cornhill, on the night of Nov. 17, 1838, was placed in charge of a stove heated by charcoal (one of Harper and Joyce's patent apparatus). He entered the church at eleven o'clock at night, and next morning was found dead, lying on his face, with his feet about a yard from the stove, and his head lower than his body. Much vomited food was found on the floor near his mouth. The church was so full of vapour as greatly to affect the respiration of the persons who first entered in the morning. The principal post-mortem appearances were as follows:—The countenance calm and composed, and the eyes lustrous. The vessels of the brain gorged with fluid blood; considerable serous effusion between the arachnoid and pia mater, and at the base of the brain; numerous bloody points in its substance. The lungs almost black, the vessels turgid with blood, the trachea containing a frothy mucus, and the lining membrane injected; the blood in the large veins dark, but fluid; the stomach nearly full of undigested food. Every other part of the body healthy.

* 'Annales d'Hygiène,' vol. xxiii. p. 190.

inquest there was great difference of opinion among the itnesses as to the cause of death. They all agreed that ɔd of apoplexy; but some thought the death sufficiently by his advanced age and apoplectic make, and the full n before he commenced his watch in the church. But ɔugh they also attributed the death to apoplexy, traced xy itself to the carbonic acid.

estion to be decided, therefore, ultimately took this 'as there enough carbonic acid in the church to account ; and if the quantity diffused through the church was ɜnt to account for the fatal event, might not the part ıe lay (for he was on the floor close to the stove) contain t quantity of the gas to prove fatal? As similar cases, like questions, may again occur, it may be well to say a on each of these points.

ıt is the smallest quantity of carbonic acid diffused he air that may prove fatal?

ıe carbonic acid produced in the burning of fuel in ɔuildings equally diffused, or does it accumulate in one ɜ apartment more than another?

stimating the fatal dose of carbonic acid, it should be nind that when the gas is the product of respiration or n it is formed at the expense of the oxygen of the air; ıe air is rendered less fit for the support of life by the ıl of a vital element, as well as by the addition of a The different susceptibility of persons of the two sexes ɜnt ages should also be considered (see p. 265). Some rown on this question by the experiments of Allen and ıich showed that air once inspired becomes charged with 8½ per cent. of carbonic acid, and that, however often breathed, it never acquires more than 10 per cent. ıtal consequences have more than once ensued from ɜercrowding, when the pollution of the air, in all y, fell far short of this limit, we may safely assume that naller quantity of the gas would destroy life. Devergie ıt five per cent. is sufficient, but Mr. Coathupe* states suffered most severely from inhaling an atmosphere ɡ, at the outside, according to his own calculation, 2 per

ɜhael's Church contained 110,000 cubic feet of air, and ity of charcoal burnt might have yielded 1500 cubic feet ɜ, or little more than 1½ per cent. The quantity of the gas

* 'Lancet,' vol. xxxi. p. 201.

diffused through the building was thus probably much smaller than that contained in rooms crowded, ill-ventilated, and lighted by gas, and probably too small to destroy life, though breathed for several hours by a sleeping man. The death of James Trickey could not therefore be attributed to carbonic acid gas, on the supposition that the gas was uniformly diffused through the building. But if, as some believe, and as the experiments of Devergie seem to prove,* the gas is unequally distributed, and, when the temperature of the apartment has become the same in every part, subsides to the floor, the death of James Trickey, who lay on the floor of the church within three feet of the stove, was probably due to the poisonous gas which he inhaled. But the death of James Trickey may be explained without assuming this subsidence of the gas to the floor of the building; for except in those cases in which the heated gas given off from the burning fuel rises in a column to escape by a vent in the ceiling directly above it, it must be diffused in larger quantity through the air near the stove, whether above, around, or beneath it; and if the gas were borne by a draft in the direction of the sleeper, the danger would be greatly increased. But if the draft were strong, it would clear the air of the gas, and so diminish or remove the danger. This occurred in a case reported by Dr. Golding Bird, which also seems to place beyond all reasonable doubt the greater accumulation of gas in the proximity of the stove than in the parts remote from it †

That such diffusion of the gas does happen may be proved by placing lime water in watch-glasses, in different positions, near the source of supply. It soon becomes coated with a film of about equal thickness, in whatever position it is placed.

The more obvious causes of an unequal distribution of carbonic gas, or of other products of combustion, are the following:—

1. Carbonic acid may be generated (as in beer-vats) in an inclosed place, and form a stratum above the source of supply, mixing very slowly with the air above and around it. 2. Carbonic acid may enter an inclosed space (such as a well, cavern, or grotto) from openings in the floor; and if the air of the upper part of the space be renewed, as by the occasional opening of a door, the lower stratum may be poisonous, while the upper strata are comparatively pure. 3. Carbonic acid may be generated in an apartment by combustion, and rise as a compact column of heated air to a vent in the ceiling; or it may be drawn towards

* These experiments derive some confirmation from a case quoted by Devergie from a work by M. Marye, for which the reader is referred to the first edition of this work.

† 'Guy's Hospital Reports,' vol. viii. p. 84.

an open chimney; or, again, it may be forced into a particular direction by currents of air. 4. In an apartment without chimney, or other vent, and with no currents or drafts of air, or only very feeble ones, the gas will be diffused abundantly, though unequally, around the source of supply.

Other Products of Combustion.—Carbonic acid, though the chief, is not the only product of the combustion of charcoal or coal. In the case of burning charcoal, carbonic oxide is given off in large quantity by the reduction of the carbonic acid as it passes over the heated charcoal.

Carbonic oxide is a much more active poison than carbonic acid; for it acts not only by taking the place of oxygen, but by combining with the blood, and rendering it incapable of the gaseous interchange necessary to life. Warm-blooded animals die rapidly in an atmosphere containing only 1 per cent. of carbonic oxide. They die with symptoms of dyspnœa passing into convulsions and asphyxia. After death the blood has a florid colour, due to the compound which the poison forms with hæmaglobin.*

During the combustion of coal not only carbonic acid and carbonic oxide are given off, but also sulphurous acid, and the sulphuretted and carburetted hydrogen gases.

II. SULPHURETTED HYDROGEN (*Hydrosulphuric Acid.*)

This gas ranks next in importance to carbonic acid. It is scarcely less generally diffused, but its offensive odour gives warning of its presence. It is an extremely active poison, for according to Thénard atmospheric air which contains $\frac{1}{1500}$th of its volume will destroy a bird; when $\frac{1}{800}$th of its volume it will kill a dog; and $\frac{1}{250}$th proves fatal to a horse. Injected into the blood, it speedily destroys life; and it proves fatal when introduced into any of the cavities of the body, or even when applied to the unbroken skin.

Properties.—This gas has a peculiarly offensive odour—that of rotten eggs; and it is remarkable for the variety of its reactions with the metallic bases. It combines with ammonia to form the sulphide of ammonium, which has a similar offensive odour added to the pungency of hartshorn, and similar chemical reactions. The presence of ammonia is indicated by the fumes given out when a rod dipped in hydrochloric acid is held in the gas.

Tests.—The usual test for this gas is acetate of lead, which throws down a brown or black precipitate, according to the

* In man the symptoms and appearances are usually complicated with the effects of carbonic acid and other gases.

quantity of the gas. Filtering paper moistened with
of the salt of lead is a very delicate test.

Symptoms.—When the gas is breathed in a moderate
state, it causes giddiness, a sensation of tightness
temples, and of oppression at the pit of the stomach
sudden weakness, and loss of sense and motion.
tetanus, and convulsions, a cold skin, an irregular and
quent pulse, and laborious respiration, are occasionally

Post-mortem Appearances. The body has a highly
odour, and quickly undergoes decomposition. The
dark, and insensible to the stimulus of galvanism.
vessels and all the internal viscera are distended
liquid blood.

Treatment.—This consists in prompt removal to
the use of stimulants, and the respiration of *chlorine* gas
off from bleaching powder moistened with a dilute acid,
any of the bleaching liquids. As chlorine is a powerful
it should not be administered in too concentrated a form.

Sulphuretted hydrogen rarely exists in a separate
poison; but is most commonly met with in union with
in privies, cesspools, and common sewers.

Feculent matter in a state of putrefaction gives rise
principal gases—sulphuretted hydrogen, sulphide of am
and nitrogen. The first two are exceedingly deleteri
latter possesses negative properties. They exist separ
combined in the soil of privies. Sometimes it happens
disagreeable odour is given out; neither the nauseous
the sulphuretted hydrogen, nor the irritating and
odour of the sulphide of ammonium, but still the air
taminated. In these cases the gases consist of carbonic
nitrogen, with a very small proportion of oxygen.

The symptoms and post-mortem appearances caused
mixed gases do not differ much from those due to the in
of sulphuretted hydrogen alone. The rapidity with wh
symptoms take place will be proportioned to the degree
centration of the gas. The most remarkable symptoms p
in those who have been suddenly and strongly affected a
sequently recovered (such as the men employed to em
common sewers in Paris), are, a feeling of violent pressur
epigastrium, and round the head.

To purify the air, as well as to recover persons asphyxi
these gases, chlorine is the proper agent.

The gases arising from the stagnant water of sewers are
to those given off by privies and cesspools; but they ar

dissolved by the water. In sewers with a good fall and liberal supply of water no gases are given off; but there is a peculiar animal odour due to their feculent contents. This does not appear to affect the health of the men who work in sewers.

III. CARBURETTED HYDROGEN.

The chief constituent of coal gas is the combination of carbon and hydrogen, known as light carburetted hydrogen, sub-carburetted hydrogen, marsh gas, or fire damp. In coal gas the light carburetted hydrogen is mixed with olefiant gas, and unless of unusual purity contains ammonia, sulphuretted hydrogen, carbonic acid, and carbonic oxide, with free hydrogen and nitrogen.

Properties.—These mixed gases have a peculiarly offensive odour. They burn with a yellowish-white flame, yielding chiefly water and carbonic acid, and forming, with certain proportions of atmospheric air, a dangerous explosive mixture.

Coal gas is not so active as carbonic acid or sulphuretted hydrogen; but when mixed with an equal bulk of atmospheric air it cannot be breathed without producing very serious effects. If greatly diluted, as in coal mines, no bad effects follow.

Symptoms.—Very few cases of poisoning by coal gas, or its principal constituents, are recorded. In a case described by Devergie, there were foaming at the mouth, vomiting, violent convulsions, tetanic spasms, stertorous respiration, bloated face, and dilated pupil.

Post-mortem Appearances.—From two cases reported by Mr. Teale,* it seems that the principal morbid appearances are the following:—Pallor of the integuments, and of the internal tissues generally, with the exception of some portions of the mucous membrane; florid discoloration of the neck and back; light florid colour of the muscles; absence of all indications of venous congestion; the blood fluid and florid; infiltration of the lungs; injection and ecchymosis of the small intestines, and of the air-passages. Rigidity rapidly supervenes.

Treatment.—This consists in prompt removal into the air, and the cold affusion, followed by diffusible and other stimulants.

IV. NITROUS OXIDE (*Laughing Gas*).

Nitrous oxide, prepared by the distillation of ammonium nitrate, is now largely used as an anæsthetic; and so used it has proved fatal in one or two cases.

Symptoms.—When nitrous oxide is inhaled, it gives rise to a peculiar state of intoxication often of a hilarious nature (hence

* 'Guy's Hospital Reports,' No. viii. p. 106.

the name laughing gas); and when the inhalation is continued for a minute or two a state of insensibility comes on, during which short operations, such as the extraction of teeth, can be performed without pain. During this state of insensibility the face becomes livid and the pupils dilated. If the inhalation be continued, dangerous, and even fatal, symptoms of asphyxia manifest themselves.

Animals made to breathe an atmosphere of nitrous oxide die with all the symptoms of asphyxia. The anæsthesia produced by nitrous oxide appears to be chiefly due to its action as an asphyxiant, and not to any special narcotic power, though the feeling of exhilaration caused by it may indicate that it is not to be regarded merely as a passive agent.

Purcell ('Phil. Med. and Surg. Report,' 1872, p. 343) reports a case of death from the use of nitrous oxide in dentistry. Death was sudden, but it was doubtful how much of the fatal result was due to asphyxia and how much to shock. A similar case occurred at Exeter in 1873 ('Brit. Med. Jour.,' Feb., p. 126), which gave rise to much dispute as to the cause of death. As a post-mortem examination was not allowed, it is impossible to say what share the nitrous oxide really had in the untoward result.

Treatment.—The treatment is that for asphyxia generally. *See* CHLOROFORM, p. 562.

CHAPTER XVI.

VEGETABLE IRRITANTS.

1. PURGATIVES.—Aloes, colocynth, gamboge, jalap, scammony, seeds of the castor-oil plant, croton oil, elaterium: the hellebores and colchicum.
2. ABORTIVES.—Savin, and ergot of rye.
3. IRRITANTS, WITH NERVOUS SYMPTOMS.—Cicuta virosa, phellandrium aquaticum, æthusa cynapium, yew, and laburnum.
4. SIMPLE IRRITANTS.—Arum, mezereon, ranunculus, bryony (white and black), &c. &c.
5. DISEASED AND DECAYED VEGETABLE MATTERS.

I. PURGATIVES.

THIS group comprises both the more active purgatives now used in medicine, or by the vendors of aperient pills, and the now disused hellebore, which was in earlier times so largely given for the cure of melancholic disorders. Of the purgatives now in use it may suffice to state that, when given in large doses, or to old and infirm persons, they may act as poisons. All those enumerated at the head of the chapter, given alone or in combination, have proved fatal. Their poisonous property resides chiefly in their oily or resinous constituents. Aloes and jalap yield active principles—*aloine* and *jalapine*, and colchicum, *colchicine*.

The *symptoms* produced by this class of poisons are those of irritation of the alimentary canal—vomiting and purging, with pain in the abdomen, cramps, tenesmus, and strangury. The patient falls into a state of collapse, attended sometimes with drowsiness and slight nervous symptoms.

The *post-mortem appearances* are those of inflammation of the alimentary canal in various degrees and stages—redness, ulceration, softening, and effusion of dark blood into the submucous tissue.

The *treatment* consists in the free use of diluents, with opium to relieve pain, and stimulants to counteract collapse.

Some medicines belonging to this group deserve special mention.

ALOES.—This drug owes its importance to the large number

of its preparations. The British Pharmacopœia contains no less than ten preparations, and in most quack aperient pills it is a leading ingredient. Mixed with powdered canella, in the proportion of four parts to one, it is the well-known aloetic powder, hiera-picra, or holy bitter. This popular remedy, as well as the quack pills which people are encouraged to take in any quantity, have proved fatal. Aloes yields an active principle (*aloine*), distinguished by giving with cold sulphuric acid a yellow colour, greatly heightened when the solution is warmed, and changing to green when heated. It is also turned orange by nitric acid.

Jalap.—This also is a drastic purgative, which yields an active principle (*jalapine*) characterized by the yellow tint it gives to cold sulphuric acid, heightened to deep orange when warmed, and to a red-brown when heated. It is turned yellow by nitric acid.

Fig. 172.

Castor-oil Seeds.—Of the seeds of the ricinus communis, or castor-oil plant (fig. 172) it will suffice to state that they act on the stomach and intestines with a violence quite disproportioned to the action of the oil which they would yield on compression. Two or three seeds act as a drastic purgative; three seeds have destroyed the life of an adult male in forty-six hours, and twenty seeds that of a young lady in five days, with symptoms of violent irritation of the stomach and bowels, and an appearance as of "one affected with malignant cholera."

Croton Oil.—The expressed oil of the croton tiglium (fig. 173) has more than once destroyed life with symptoms of acute irritant poisoning, and collapse resembling that of the worst forms of English and Asiatic cholera. The following is an abstract of a case described by Dr. Greenhow:—

An old lady took by mistake an embrocation containing 30 minims of the oil. When seen two hours afterwards, she had all the appearance of a person in the cold stage of cholera. There had been profuse purging of matters exactly resembling the rice-water stools of cholera patients, and severe cramps. The surface was cold, the features shrunken, the skin even more blue than is usual

in cases of true cholera, the pulse thready and almost imperceptible, and the respiration gasping. She was very restless; but her intellects were unimpaired, and she died in ten hours after taking the poison.*

Fig. 173.

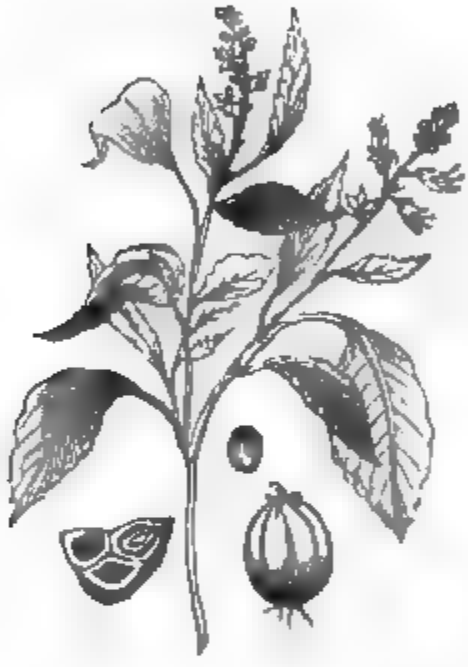


Fig. 174.

ELATERIUM.—The fruit of the wild or squirting cucumber (fig. 174) yields a juice of such active properties, that the dried sediment or extract, of the British Pharmacopœia, is prescribed in a dose of from $\frac{1}{12}$ to $\frac{1}{4}$ grain, while *elaterine*, its active principle, is effective in the small dose of $\frac{1}{96}$ grain. It constitutes about a fourth part of the extract. With cold sulphuric acid, it yields a red-brown solution, deepened in tint by warming, and still more when heated. Nitric acid does not change its colour. Christison quotes from a French authority, the singular case of a medical man in Paris, severely affected with pain and tightness of the head, colic pains, purging, bilious vomiting, and fever, through carrying a specimen of the plant in his hat for twelve hours.

THE HELLEBORES.—The *helleborus orientalis*, or true hellebore, with its black root, or *melampodium*, was largely used by the ancients as an efficient purgative in disorders, bodily and mental, supposed to depend upon black bile.

* 'Medical Times and Gazette,' August, 1866, p. 142.

The *helleborus niger*, or black hellebore, is named, like the oriental species, from the dark or black colour of its root; and hence, also, the name "Melampodium" of the old Pharmacopœias. It grows in shady woods, and flowers in January, as the "Christmas rose." (Fig. 175.) The leaves and root are poisonous; and the powdered root is a brisk purgative, and, as well as the leaves, a favourite but dangerous worm-medicine with the vulgar.

Fig. 175.

The *symptoms*, *post-mortem appearances*, and *treatment*, are those proper to irritant poisons generally (p. 378), with violent action on the bowels, and marked symptoms of collapse. A decoction of the root has destroyed life in less than two hours, after producing vomiting, delirium, and convulsions.

The *helleborus fœtidus* (fig. 176), stinking hellebore, bearsfoot, or fetter wort, is also a very virulent poison, having a similar action to the preceding, but more powerful. It is known in Westmoreland, where it grows abundantly, as *felon-grass*. It has long been in use as an efficient vermifuge.

COLCHICUM (*Colchicum autumnale*, *Meadow saffron*).—This plant grows in moist meadows in every part of Europe. It flowers in autumn, and throws out its leaves in spring; and it has a fibrous root attached to the under side of an underground stem or corm. The fruit, which ripens about midsummer, contains several hard round seeds. Figure 177 shows the plant (A), the flower (B), and the capsule (C). The corm and seeds are used in making several preparations of the British Pharmacopœia—the fresh corm for the extract, and acetic extract, the dried corm for the wine, and the seeds for the tincture. The corms

have been taken by mistake for onions; and the seeds, wine, and tincture have also been taken in poisonous doses.

Fig. 176.

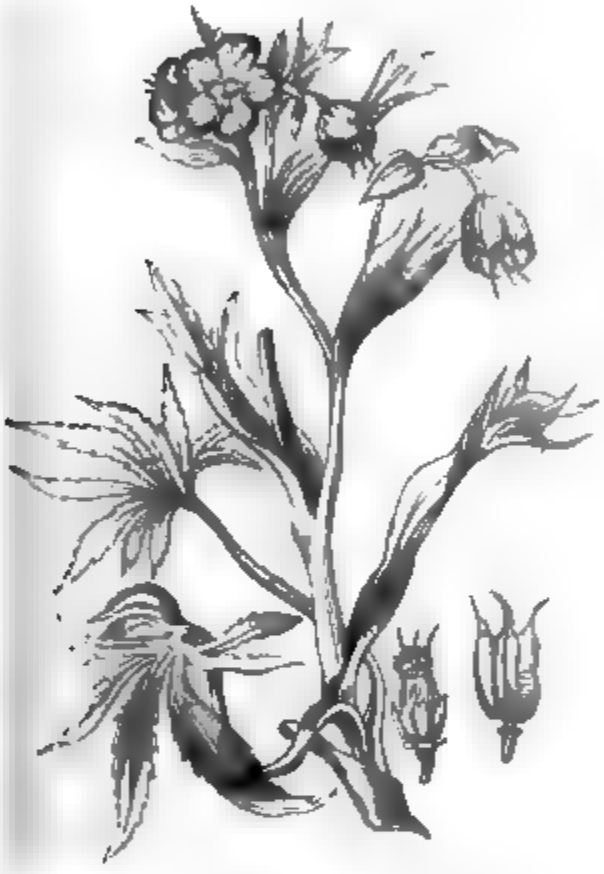
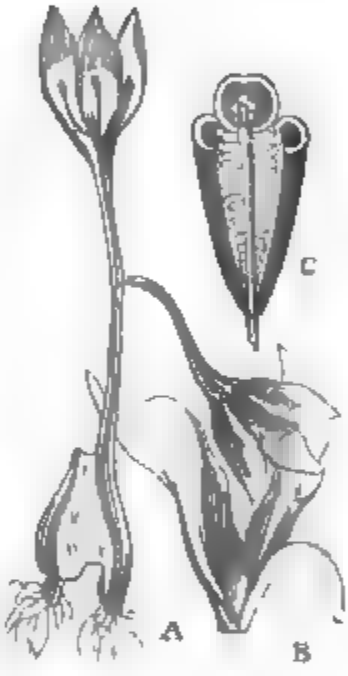


Fig. 177.



The *symptoms* are sometimes slow in showing themselves, even when large doses of the wine or tincture are taken; but in other cases they begin almost immediately, and death may take place in as short a time as seven hours. The symptoms are those of irritation of the alimentary canal, with collapse. Nervous symptoms are rare. The *post-mortem appearances* and *treatment* are those proper to poisoning by the irritants (p. 379). Stimulants must be freely used to counteract the extreme debility.

The seeds of colchicum are globules of a reddish-brown colour, very hard, and shrivelled on the surface, of the size shown in the figure, and weighing eight, ten, or twelve to the grain.

Fig. 178.

Colchicum owes its poisonous properties to an alkaloid, allied to veratria, and named *colchicina*, of which less than half a grain has proved fatal to

an adult. Toxicologically colchicum and colchicina have been but imperfectly investigated.

II. ABORTIVES.

Savin (*Juniperus sabina*).—A small indigenous bushy shrub yielding a round purple fruit about the size of a currant (fig. 179). It has a peculiar, strong odour, and an acrid taste; and owes its irritant properties chiefly to an essential oil readily ob-

Fig. 179.

Fig 180.

tained from the fresh tops of the plant by distillation with water. This oil, and an ointment from the freshly bruised plant, are in the British Pharmacopœia. The dose of the oil is from one to five minims.

The leaves, in powder or infusion, and the oil, are often given to procure abortion; but it is more frequently fatal to the mother than effectual in destroying the child. Savin is also occasionally used as a vermifuge.

Symptoms.—Those of irritation of the alimentary canal. Severe pain in the belly and vomiting, and sometimes strangury, but diarrhœa rare. Salivation and insensibility are occasional symptoms.

Post-mortem Appearances.—Those of acute inflammation of

the alimentary canal. The green powder is often found among its contents. On drying and rubbing this powder, it emits the peculiar odour of the plant, and the hard thick parts of the twigs exhibit under the microscope the ordinary characteristics of coniferous wood. Watery solutions of savin strike a deep green with perchloride of iron.

Treatment.—That proper to the whole class of irritants (p. 379).

ERGOT OF RYE (*Spurred rye, Secale cornutum*).—This is the product of a disease attacking the grain of several plants, such as wheat, barley, oats, and rye, in wet seasons, and in ill-drained soils. The ear of the plant is occupied wholly, or in part, by the diseased grains, each of which is of a deep purple colour, elongated, slightly curved, and projecting, so as to bear some resemblance to a cock's spur. These diseased grains, collected, dried, and powdered, form the ergot of the shops, used by the accoucheur to promote contraction of the uterus, and sometimes criminally given to procure abortion. Fig. 180 shows side by side the healthy (1) and diseased plant (2), an enlarged spikelet (*d*), a section showing the sporidia (*k*), the sporules (*l*), and two entire and full grown samples of the ergot (*g* and *h*).

Properties.—The ergot, when entire, varies in length from a quarter of an inch to two inches, and in thickness from a sixth to a third of an inch. Its surface is black, with lighter dotted streaks, and its substance reddish-grey. It is lighter than water, has a disagreeable odour, and somewhat acrid taste.

Tests.—*a.* Liq. potassæ gives it a lake-red tint, and developes the characteristic odour. *b.* The filtered alkaline liquid has the same colour, and lets fall the same coloured precipitate, on the addition of nitric acid, or a solution of alum in excess.

Experiments on Animals.—The symptoms produced in animals by large single doses, or by smaller doses frequently repeated, are partly those of intestinal irritation, partly those indicative of affection of the nervous centres. To the first belong diarrhœa, to the last giddiness, dilated pupil, drowsiness, convulsions, and paralysis. Suppurating tumours, and gangrene of the extremities, are also among the symptoms.

In the human subject a single full dose gives rise to irritation of the stomach and bowels, giddiness, headache, and flushing of the face, with great lassitude and weariness. The uterus is excited to contraction, and in a pregnant female abortion may occur. No cases of acute poisoning with ergot are on record.

When the spurred rye, or other grain similarly diseased, is mixed with flour and made into bread, it gives rise to an epide-

mic malady, which assumes the form either of *convul* *gangrenous ergotism*. In the first form nervous sympt as giddiness, weakness of the limbs, mental incapac and convulsions predominate; in the latter, dry gangre extremities. Both forms are preceded by symptom referable to intestinal irritation.

III. IRRITANTS WITH NERVOUS SYMPTOMS.

This group of poisons may be considered as the uncle nant of the large division formerly known as the *irritants*. Their very decided action on the stomach an separates them from the group of convulsives of which is the type, and from that of depressants, of which conii best representative. Cicuta virosa is allied to the firs num, perhaps, to the second.

CICUTA VIROSA (*Water Hemlock, Cowbane*).

This is a perennial, indigenous, umbelliferous plant, in wet ditch the banks of flowering in August. It three or fou height, has a stem, and lar green triparti The leaflet grouped in threes, narrow shaped and s and the le are of a reddis where attache stem. The flo borne on mar umbels. Th stalk, which l repeatedly u for the parsne low and fille large cells. I shows a cuttin plant, with s and calyx.

Fig. 181.

The cicuta virosa has been described as "by far the most active of the poisonous plants of Great Britain;" and reasons have been assigned for the belief that it supplied the "celebrated Athenian poison."*

In *animals* the root gives rise to tetanus. In *man* well-marked tetanic spasms are also among the prominent symptoms, together with dilated pupil, insensibility, coma, nausea, vomiting, and diarrhœa. Death may take place within an hour of the swallowing of the poison.

Wepfer gives the cases of two boys and six girls who ate more or less largely of the roots. The boys who took a large quantity were soon seized with acute pain in the stomach, loss of speech, insensibility, and terrible convulsions. The mouth was so closely shut that it could not be opened, blood flowed from the ears, and the eyes were horribly distorted. Death took place in half an hour. The girls suffered from epilepsy.

The cases of three German soldiers related by Boerhaave show that the *post-mortem appearances* were well marked. They, too, died in less than half an hour; and the stomach of one was found perforated, the stomachs of the others corroded.

Fig. 182.

PHELLANDRIUM AQUATICUM (*Fine-leaved Water Hemlock*).

This, too, is an indigenous umbelliferous plant, growing in similar situations with the foregoing, and of which the tapering root eaten by mistake for parsneps has produced poisonous effects. The plant grows to about three feet in height, and is furnished with small finely-divided dark-green leaves. (Fig. 182.)

ÆTHUSA CYNAPIUM (*Fool's Parsley*).

The leaves of this plant, as its name implies, have been eaten

* Stephenson and Churchill's 'Medical Botany,' vol. ii. pl. 60.

by mistake for parsley; and the roots for young turnips. It is an annual umbelliferous plant, growing in gardens and fields, and may be recognised by the secondary involucres appended to the flower-stalks, which are composed of three long and narrow drooping leaflets (bracts). When rubbed, the leaves have a nauseous odour. Though it has been said to cause convulsions and stupor in animals; and heat of mouth and throat, nausea and vomiting; headache, giddiness, stupor, dilated pupil, convulsions, and locked jaw, in *man*, Dr. Harley has just proved by careful experiments that it is a harmless plant.[a]

Fig. 183.

YEW (*Taxus baccata*). — The leaves and berries of the yew (fig. 184) are poisonous. The leaves have proved fatal to animals, and the leaves and berries to man. The leaves, or an infusion of them, are sometimes given as a vermifuge or abortive.

Symptoms.—Those of irritant poisoning, with the addition of nervous symptoms, such as insensibility and convulsions. Death may take place quickly from collapse; or, at a later period, from inflammation of the alimentary canal. The leaves have killed an adult in fourteen hours, and the berries a girl five years old in four hours.

Post-mortem Appearances.—Those of irritation of the alimentary canal. The leaves or berries are generally found in the stomach, and are readily identified. The leaves are lancet-shaped; and the berries, the size of a pea, consist of a hard,

[a] On the Action of Fool's Parsley. By John Harley, M.D. 1874.

brown, egg-shaped seed, enclosed in a light red covering, and surrounded by a colourless viscid juice, which has an acid reaction and a nauseous taste.

Fig. 194.

LABURNUM (*Cytisus laburnum*). —All parts of this plant appear to be poisonous, and cases are on record of poisoning by the seeds, flowers, and bark. The plant has a most nauseous and disagreeable odour and taste. It owes its poisonous properties to an alkaloid known as *cytisin*. From Christison's experiments with the dried bark, it may be inferred that the laburnum is extremely active, producing in a few minutes violent tetanic convulsions, and speedy death. In man, too, the symptoms are very well marked, consisting of violent irritation of the alimentary canal, with great exhaustion, drowsiness, and rigidity of the limbs, convulsions, dilated pupil, and frequent pulse.

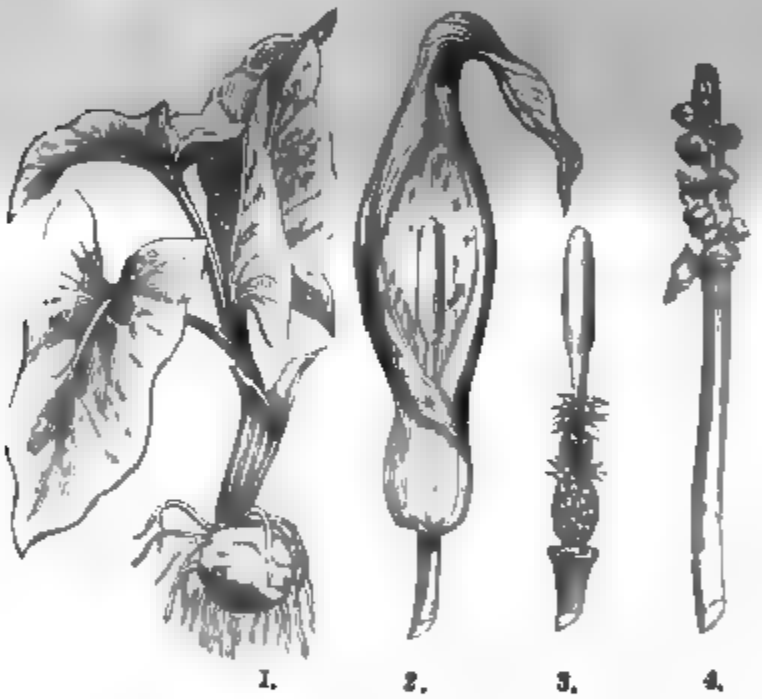
But two cases of poisoning by the bark eaten by a girl of ten, and a boy of eight, in mistake for liquorice, reported by Mr Sedgwick, of Boroughbridge, show that the laburnum does not always produce the symptoms just enumerated. They were such as to qualify the plant for a place among depressants rather than convulsives. The symptoms of depression preceded the administration of tartar emetic as a vomit. In the boy the symptoms set in an hour and a quarter after eating a piece of the root the size of a walnut; in the girl, who had eaten about three times as much, they began after about the same interval. In both, the first symptoms were vomiting, giddiness, extreme weakness, pallor and coldness of the skin, and a feeble fluttering pulse. The pupil was dilated. Drowsiness showed itself later; but there was at no time any marked pain of the abdomen, nor any purging. Besides the drowsiness there were no head symptoms.*

* 'Medical Times and Gazette,' Jan. 3, 1857. See also similar cases by Wheelhouse ('Brit. Med. Journ.' 1870, No. 473), and Tinley ('Lancet,' 1870, vol. ii. 6).

IV. SIMPLE IRRITANTS.

ARUM (*Arum maculatum, lords and ladies, cuckoo-pint*).—The green spotted arrow-shaped leaves (1) of this plant appear early in spring in hedgerows, woods, and shaded spots; the green spathe (2), with its purple column (3) enclosed, in May; and a cluster of bright-red berries (4) alone, towards the end of summer. The root is tuberous and somewhat heart-shaped, and

Fig. 185.



1. 2. 3. 4.

like all other parts of the plant, is highly acrid and irritating. The juice applied to the tongue causes acute darting pain, as if it were pierced with sharp needles; and in three children who ate of the leaves of the plant, the tongues were so swollen as to render swallowing difficult. Two of the children died in twelve and sixteen days respectively: the third recovered. The poisonous properties of the plant are wholly dissipated by heat; and the roots, first steeped in water, and then baked and powdered, constitute the "*Portland sago.*" The *symptoms*, *post-mortem appearances*, and *treatment* are those proper to irritant poisoning (p. 378).

MEZEREON (*Daphne mezereum*).—This is a cultivated garden shrub yielding bright red berries, apt to attract the notice of children, and to be mistaken for currants (fig. 186). They con-

tain a single ovate seed, composed of two plano-convex cotyledons enclosed within the coat. The plant has highly irritating properties. Five or six of the berries are sufficient to produce serious effects. The bark is an ingredient in the compound decoction of sarsaparilla of the British Pharmacopœia, and is the basis of the ethereal extract of mezereon. The *symptoms*, *post-mortem appearances*, and *treatment*, are those of irritant poisoning (p. 378).

Fig. 186.

RANUNCULUS (*Crowfoot*, *buttercup*). —There are no less than fifteen species of ranunculus, or crowfoot, natives of these islands, and common in our meadows and pastures, and most of them have more or less irritating properties. Those which are esteemed most poisonous are the ranunculus flammula, bulbosus, and sceleratus; the R. acris and arvensis being less deleterious. Fig. 187 shows a plant of the ranunculus acris. Every part of the fresh plant is pervaded by an acrid principle, which, like that of arum maculatum, is volatile, and dissipated by heat, or when the plants are dried. Water distilled from the fresh plants contains the acrid principle, as is shown by the stinging taste, and sense of heat in the stomach. The distilled water of the R. *sceleratus* yields crystals. The juice of the plants is a powerful vesicant, and prior to the introduction of cantharides was used by medical men for this purpose. It is now so used to produce ulcers on the legs by mendicants and malingerers. The distilled water of the R. *flammula* is an effectual and speedy emetic; and was greatly commended by Withering as preferable to any other when the object is to produce a quick evacuation of the stomach. The bruised leaves, too, are used as vesicants.

Fig. 187.

The *symptoms, post-mortem appearances,* and *treatment* of poisoning by the ranunculi are those of irritant poisoning (p. 378).

Bryony.—The two plants which bear the common name of Bryony, have a certain importance as poisons, partly on account of their strong irritant action, and partly from their common presence in our woods and hedgerows. Though they bear the same English name, they do not even belong to the same natural order, the White Bryony being the solitary representative among our common wild plants of the Cucurbitaceæ, while the black bryony belongs to the Dioscoreaceæ.

The *White Bryony* (Bryonia dioica, or wild vine) is very common in our woods and hedges, twining among trees and bushes, and clinging by its tendrils. The leaves are rough, the flowers small and of a faint green colour; the berries clustered, and when ripe, red, filled with a fœtid unpleasant juice, and containing six seeds and the root, spindle-shaped, fleshy, and pale in colour, often attains a considerable size and thickness. Fig. 188 shows a cutting of the plant, with a small cluster of berries.

Fig. 188.

The root of this plant was formerly in use as a medicine, and was known to occasion vomiting and purging, with symptoms of collapse, sometimes ending fatally. The berries, when eaten by children, have caused vomiting

The *Black Bryony* (Tamus communis) is also very common in woods and hedges, twining, without the aid of tendrils, and contrasting strongly with the white bryony in its leaves, which are heart-shaped, pointed, smooth, and shining; in its berries, which are ovoid; and in the colour of its root, which is black. The berries are in clusters, and when ripe, are like those of the white bryony, of a red colour. A cutting of the plant, with a cluster of berries, is shown in fig. 189. The root of this

plant has also been used as a cathartic, and the berries have made children sick.

Fig. 189.

Besides the vegetable irritants briefly noticed in this chapter, there are others of less importance, of which it must suffice to append a list. Some of them have produced the effects of irritants in the human subject, and have proved fatal, while others are inferred to be poisonous from their effect upon animals, or from direct experiment. A minute description of these poisons and of their effects must be sought for in works on Toxicology. Most of them will be found figured, with brief descriptions of their effects, in Johnson's 'British Poisonous Plants.' The following is the list in question:—Anemone pulsatilla, or pasque flower (also the A. nemorosa, A. hortensis, and A. coronaria, with other species); Caltha palustris, or marsh marigold; Chelidonium majus, or celandine; Daphne laureola, or spurge laurel; Euphorbia lathyris, or caper spurge (also other species, as the E. officinarum (fig. 190), peplus, and helioscopia; Gratiola officinalis; Hyacinthus nonscriptus, or wild hyacinth; Mercurialis perennis, or herb mercury; Narcissus poeticus, and N. pseudo-narcissus or daffodil; Rhus radicans, and toxicodendron; Paris quadrifolia (fig. 191), Sedum acre; Delphinium staphysagria, or staveracre (interesting as yielding the alkaloid *delphinia*); and the Sambucus nigra, or elder, the leaves and flowers of which, in Christison's experience, caused dangerous inflammation of the mucous membrane of the bowels, lasting for eight days. Two tablespoonfuls of the root of the Dwarf Elder (*S.*

Fig. 190.

edulus) have also proved fatal to a woman fifty-four years of age.

Fig. 191.

A

Besides the foregoing, which are indigenous plants, the Jatropha curcas, or physic nut of the West Indies; and the Hippomane mancinella, or manchineel, with other species of the same (as the H. figlandulosa, and H. spinosa), may be mentioned as possessed of highly irritating properties. (See Christison, chapter on Vegetable Acrida.)

Most of the plants in the foregoing list act as simple irritants; but there are a few, such as the Mercurialis perennis, and Paris quadrifolia (fig 191), which produce mixed symptoms of intestinal irritation and narcotic poisoning; and would, therefore, claim to be placed among the narcot-acrid poisons of the earlier toxicologists.

V. DISEASED AND DECAYED VEGETABLE MATTERS.

A few cases have occurred of poisoning by spoiled vegetables; and bread made of wheat, rye, or barley, when spoiled or mouldy, has been known to act as an irritant poison, causing flushed face, dry tongue, acute colic pains, urgent thirst and headache, vomiting and purging, exhaustion and drowsiness.

The *treatment* proper to such forms of poisoning consists in the prompt use of emetics, followed by aperients, of which castor oil is the best.

CHAPTER XVII.

ANIMAL IRRITANTS.

I. CANTHARIDES.

II. DISEASED AND PUTRID ANIMAL MATTER.

III. TRICHINIASIS.

IV. POISONOUS FISH. V. VENOMOUS REPTILES AND INSECTS.

I. CANTHARIDES.

THE Cantharis vesicatoria, Spanish fly, or blister beetle, is distinguished by the shining metallic green colour of the head, legs, and wing-cases. It contains a strong irritant poison, characterized by its energetic action on the urinary and generative organs, and is the active ingredient of several preparations of the British Pharmacopœia.* The powder and tincture have been given to procure abortion, for lascivious purposes, or merely for a joke; and both powder and plaster have been taken by mistake. Its preparations have also produced severe effects on the urinary and genital organs when applied externally. The fly owes its poisonous property to an active crystalline principle, *cantharidine*, of which half an ounce of the powder contains one grain, and the hundredth part of a grain will raise a blister on the lips.

The powder and plaster are readily identified by the small shining golden or green particles; and the powder by the simple test of heat. If so small a quantity as the hundredth part of a grain be treated in the manner described at p. 407 (fig. 53), as soon as the temperature is raised to about 212° Fahr., a white sublimate appears on the glass disk; and this, when examined under the microscope, is found to consist of crystals of cantharidine. If, however, the sublimate should be amorphous, or

* Of the tincture, containing grs. vss to the ounce; of the acetum (℥ij to ℥j); of the ointment (1 to 7); of the plaster (1 in 3); of the emplastrum calefaciens (1 in 24); of the liquor epispasticus (℥ij to ℥v); and of the charta epispastica (1 in 10½). The tincture is given internally in doses of 5 to 20 minims, the other preparations are for external use.

indistinctly crystalline, the characteristic crystals may be made to appear by treating the spot with ether. The characteristic sublimate may be procured from the five hundredth, or even the thousandth of a grain. The low subliming temperature, absence of colour, and more or less distinctly crystalline form of the sublimate, taken together, are strikingly characteristic of this powder.

Symptoms.—Soon after swallowing the poison there is a burning sensation in the mouth and throat, quickly followed by a like sensation in the pit of the stomach, increased by pressure, extending at length over the whole abdomen, and accompanied by excessive pain in swallowing, dryness of the fauces, great thirst, copious discharge of blood or bloody mucus from the stomach, mixed with shining green particles, and, in less quantity, from the bowels; tenesmus, pain in the loins, distressing strangury, bloody stools and urine, and priapism, with swelling and inflammation of the genital organs. The patient is extremely restless, the breathing laborious, and the pulse quick and hard. Sometimes headache, delirium, and convulsions, tetanic spasms, symptoms allied to those of hydrophobia, and coma are superadded.

Among the occasional symptoms are blisters of the mouth, salivation, vomiting of tenacious mucus of the shape of the gullet, or of the mucous membrane itself, redness of the eyes, and lachrymation, and albuminous urine.

The tincture, in small doses of four or five drops, produces a marked effect on the urinary organs, curing incontinence of urine, sometimes without causing pain. On the other hand, very large quantities, as six ounces of the tincture, or two drachms of the powder, have been taken without bad effect, a fact only to be accounted for by the badness of the preparation.

Fatal Dose.—Of the tincture, one ounce; of the powder, not ascertained. Two doses of twenty-four grains each, taken at an interval of a day, have destroyed life, after producing abortion.

Fatal Period.—Usually from twenty-four to thirty-six hours, but it may be fatal after some days of suffering.

Post-mortem Appearances.—Marks of inflammation in different degrees and stages in the whole length of the alimentary canal, and in the urinary and genital organs. The stomach is inflamed, and may be gangrenous, in patches, where the powder has adhered; sometimes it is abraded, sometimes softened. The brain has been found gorged with blood, and the genital organs gangrenous. The powder may be found in the stomach long after death. When given in powder, or taken as plaster, the blister-

ing fly may be detected in the contents of the stomach by the glistening golden or green colour of the particles, which may be readily seen by the lens or microscope. They may be collected, dissolved in ether or chloroform, evaporated to the thickness of an extract, and its blistering property tested by application to the lip. By these two tests Barruel detected cantharides in some cakes of chocolate maliciously given to several persons. The sublimation by heat is still more satisfactory.

When the stomach has been discharged by vomiting, or the bowels emptied by aperients, the poison may still adhere to the coats of the canal. In this case we follow the plan recommended by Ponmet.* The intestinal canal having been detached, is inflated and dried; and portions of it are placed on sheets of glass, and carefully examined for the shining green spots. *M.* Poumet has detected them seven months after interment.

Treatment.—There is obviously no antidote to this poison. Vomiting is to be excited and encouraged by emetics and warm liquids; and the poison to be removed from the bowels by full doses of castor oil. The free use of diluents, with oily or demulcent injections into the rectum and bladder, and leeches or bleeding, if the inflammatory symptoms run high, constitute the remainder of the treatment. Laudanum may be added to the injections, or opium suppositories introduced into the rectum.

Cantharidine.—This is sold in the form of sparkling colourless crystals, which, when examined by the microscope, are found to consist of plates of various forms, lengths, and thickness.

Fig. 192.

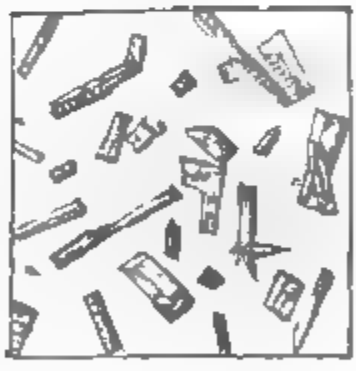


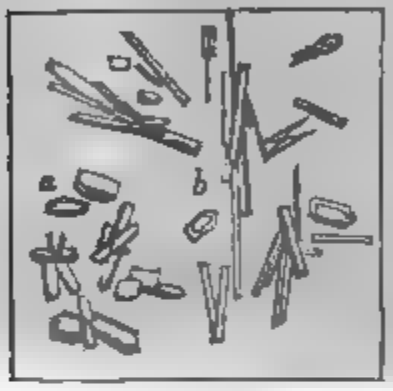
Fig. 192 is taken from a good commercial specimen. It retains similar forms, but more delicate, and with some variety of grouping, in deposits from its solutions in ether and chloroform, and in its sublimates. The deposits from ether are commonly long quadrangular plates, those from chloroform square plates and shorter oblongs. Fig. 193 shows the two forms most common in the sublimates—namely, the short plates (*a*) and the long plates (*b*). It is taken from photographs.

Cantharidine, when heated in the manner described at p. 406 (fig. 50), sublimes without residue, or leaving a faint stain only, and settles on the glass disk in such forms as those shown in fig.

* 'Annales d'Hygiène,' 1843, p. 347.

193. It may be wholly dissipated without liquefying; but if the heat be applied suddenly it melts. When treated in the manner described at p. 407, it sublimes at 212° Fahr.

Fig. 193.



× 50.

The action on cantharidine of sulphuric acid distinguishes it from almost all the active principles of vegetable origin. The acid produces no change of colour in it even when warmed and heated. Nor is its colour changed by nitric acid. These two negative reactions taken together distinguish cantharidine from every poisonous alkaloid or analogous active principle.

Cantharidine also differs from the vegetable alkaloids and glucosides in leaving no deposit of carbon when heated, and in the temperature at which it sublimes, as well as in the form of its sublimate, it differs from the mineral poisons, arsenious acid, and corrosive sublimate.

II. DISEASED AND PUTRID ANIMAL MATTER.

There is a disease prevalent among cattle in some parts of the Continent, but less known in England, which consists in the formation of large boils upon different parts of the body. The flesh of animals dead of this disease has often produced severe effects by contact with the skin, and when eaten has destroyed life either by producing violent cholera, or by creating a similar disease to that under which the animal laboured. The glanders communicated to man from the horse, and the diffuse inflammation excited by punctured wounds inflicted in dissection, or in preparing meat for the table, are familiar examples of the effect of diseased animal matter applied externally.

Putrid Animal Matter may cause severe and dangerous symptoms of irritant poisoning. The articles of food which have most frequently acted as poisons are sausages (especially those made of liver and blood), bacon and ham, cheese, and goose grease. The poisonous quality of the food appears to be developed only in the first stages of putrefaction.

The *symptoms* rarely come on till the lapse of three or four hours. The irritation of the alimentary canal is accompanied either by symptoms of collapse or of narcotism.

The milk of cattle fed in pastures containing poisonous plants, the flesh of game which has fed on certain berries, and the

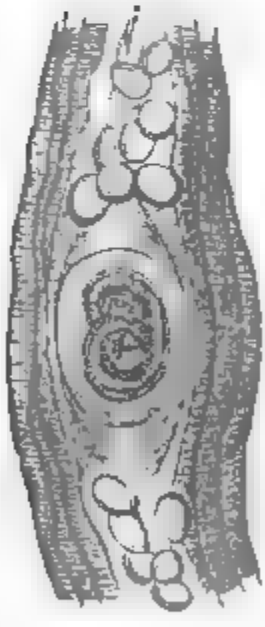
ney of bees collected from poisonous flowers, produce delirium l symptoms of narcotic poisoning.

The *treatment* of these cases, after the removal of the poison m the stomach, would be determined by the nature of the ptoms present.

III. TRICHINIASIS.

A very formidable malady in man and the domestic animals, is e to the reception into the stomach of the ova of the entozoon own as the *Trichina spiralis*. The vehicle by which they are nveyed into the stomach is the raw or imperfectly-cooked sh of pork, whole or made into sausages. The disease is most quent in Germany, but several cases have occurred in England. Germany it has more than once appeared as an epidemic; and Hettstädt, in Prussia, no less than eighty persons in a popula- n of about 5500 were attacked by the disease through eating dly-cooked sausages, made from meat infected with the para- e. Eighteen or twenty persons had died before the subject ame properly understood. The disease so common in Germany that Dr. Zenker, Dresden, found trichinæ in as many as body in every thirty-four inspected by

Fig. 194.



× 50.

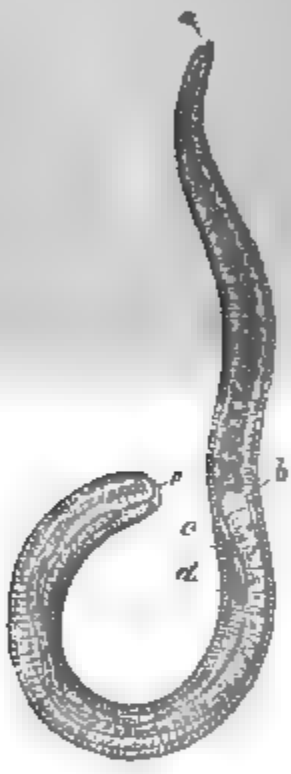
he trichinæ begin to be developed very after they are swallowed; males, fe- s, and embryos in very large numbers ; produced in the intestinal canal, and e finding their way into the muscles, s they become encysted and inert. are seen in the muscles, between the s of fibres, as opaque white specks. 194 shows the trichina coiled up its cyst, with groups of fatty cells ier end; while fig. 195 exhibits it d from its cyst. In this figure *a* re- s the mouth, *b* the commencement alimentary canal, *c* and *d* a tubular s dark granular body, extending to extremity at *e*.*

toms.—In many cases the disease sets in with diarrhœa. e extreme weariness and depression, loss of appetite, ea, febrile symptoms, severe pains in the muscles, with s œdematous swellings of the joints, followed occasionally

* Griffith and Henfrey's 'Micrographic Dictionary,' art. Trichina.

by painful persistent contractions of the flexors of the limbs. In some instances, typhous symptoms come on, and the patient dies unconscious; but the more common termination is by pneumonia. In fatal cases death occurs within a month of the ingestion of the food containing the parasite.

Fig. 105.



Post mortem appearances.—The muscles are found of a pale reddish-grey colour, speckled with small lighter coloured spots, which are the trichinæ in all stages of growth. They are found in all the voluntary muscles, and in the heart.

Treatment.—There is no remedy for the disease. The existence of trichinæ should inspire caution in selecting pork for food, and in rejecting as dangerous pork and sausages which have not been properly cooked.

IV. POISONOUS FISH.

Some fish are constantly poisonous, others only occasionally so, and others again, or parts of them, act injuriously on certain persons only. The most important of these is the common *mussel*, which becomes poisonous in certain circumstances not yet well understood.

The symptoms generally show themselves after one or two hours with swelling and itching of the eyelids, and watering of the eyes, and an eruption on the skin, in most cases closely resembling common nettle-rash, and attended with intense heat and itching. Dyspnœa generally follows, but occasionally precedes, these symptoms; there is extreme weakness; and in fatal cases delirium, convulsions, and coma have supervened. Symptoms of irritation of the stomach are not always present, but in some instances there have been nausea, pain in the pit of the stomach, vomiting, and difficulty in swallowing.

The treatment consists in the free use of emetics, purgatives, and diluents. Ether may be given with advantage.

Instances are on record in which oysters, eels, and salmon have produced injurious effects. The richer fish also habitually disagree with some persons.

V. VENOMOUS REPTILES AND INSECTS.

As no difficult medico-legal questions arise out of the poisonous fects produced by the insertion of the various secretions of imals into wounds, whether inflicted by the fangs of serpents, ie stings of insects, or the claws of such creatures as the ornirynchus, or (as in the case of the cutaneous secretion of ie common toad) inoculated for the purpose of experiment, this ibject will be very briefly noticed.

In England we have but one venomous snake, the common per, or adder (Vipera berus). It is about two feet long, has a rown body, slate-coloured belly, rhomboidal dorsal scales, with a w of black spots on each side, head covered with rough scales, id poisonous fangs in the upper jaw. It appears, however, that ie colour is not always the same; for Dr. Stephenson ('Medical oology and Mineralogy,' p. 66), figures two adders found near larrow-on-the-hill, the one brown, the other blue-black.

The *symptoms* caused by the bite of the adder are sharp pain the wound, swelling, redness passing into a livid hue, and pidly extending to adjoining parts. Blisters form round the und, like those of a burn. The pain soon abates, the parts cted become œdematous and livid, and large livid spots ear on the surface. The general symptoms, which commonly w themselves within forty minutes of the bite, consist of iety, prostration, cold sweats, and feeling of giddiness and tness; bilious vomiting and diarrhœa; quick, small, and irlar pulse, and difficult breathing; to which are sometimes d convulsions, and disturbance of the mind.

ie *treatment* consists in the immediate application of a ligabetween the wound and the heart, and the removal of the by suction. Ammonia should be applied to the wound iven internally. Tincture of iodine is a useful application stings of venomous insects, and might be usefully applied wound of the viper.

venom of the *cobra di capello* surpasses that of all other in virulence. The local symptoms are of a similar chato those above described, but more intense, the bitten ming to undergo rapid decomposition. The constitutional nanifest themselves by depression, nausea, faintness, and . Paralysis of locomotion ensues, and before death, generally preceded by convulsions, there are involuntary s of a sanguineous character.

runton and Fayrer have proved that the poison paraspinal cord, motor nerves, and muscles. Death is

usually the result of the paralysis of the muscles of respiration, and if artificial respiration be kept up, the heart may continue to beat many hours after the apparent death of the animal. No case of complete recovery has, however, resulted from this method of treatment.

The injection of ammonia into the veins, which has been much praised by Halford as a successful antidote to snake-bites, was long ago tried by Fontana without success, and the recent investigations of Brunton and Fayrer do not establish the repeated efficacy of this method of treatment. The internal administration of ammonia and brandy has sometimes been found to be followed by good results.

For an account of the effects of snake-bites see Fayrer's 'Thanatophidia of India,' and a paper by Brunton and Fayrer in 'Proceedings of the Roy. Soc.,' No. 149, 1874.

CHAPTER XVIII.

DIAGNOSIS OF THE POISONOUS ALKALOIDS, AND ANALOGOUS ACTIVE PRINCIPLES.

In the later chapters of this work, which treat of the organic poisons, several active principles derived from organic matters have been described; but they have not yet been so compared with each other as to bring into relief their respective properties. This will now be done in the case of the active principles that are most important as poisons.

Those selected for comparison are Cantharidine from the animal kingdom; and Atropine, Aconitine, Brucine, Coniine, Digitaline, Morphine, Nicotine, Picrotoxine, Solanine, Strychnine, and Veratrine, from the vegetable kingdom. Of these, ten are solid stable compounds, and two only (Coniine and Nicotine) liquid and volatile. If grouped in accordance with their ultimate chemical composition, they will be found to consist of three classes—namely, those that contain—

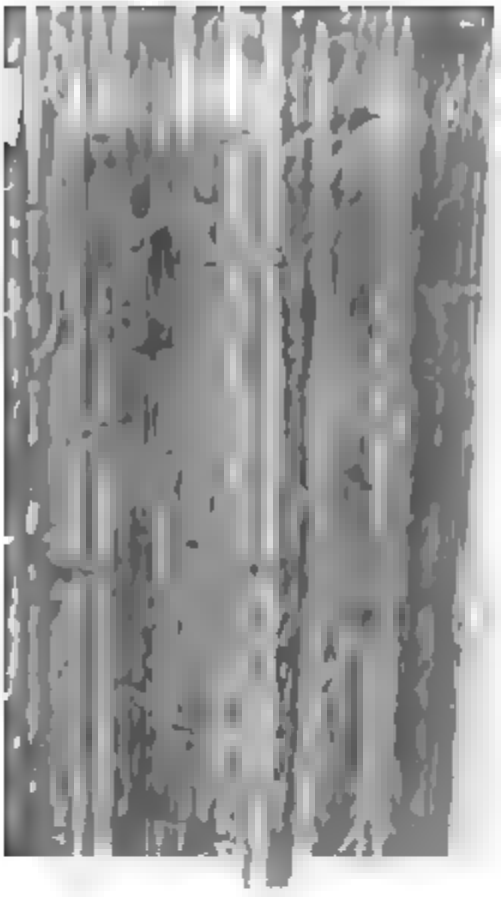
1. Carbon, Hydrogen, and Oxygen.
2. Carbon, Hydrogen, and Nitrogen.
3. Carbon, Hydrogen, Oxygen, and Nitrogen.

To the first class belong the animal product, Cantharidine, and the two *Glucosides*,* Picrotoxine and Digitaline; to the second Coniine and Nicotine; to the third, the *alkaloids*, Atropine, Aconitine, Brucine, Morphine, Solanine, Strychnine, and Veratrine.†

The chemical composition of these substances does not materially influence their reactions; for the animal product cantharidine differs in this respect from the vegetable glucoside picrotoxine as much as the alkaloids strychnine and veratrine from each other; though cantharidine is distinguished from picrotoxine only by containing, in 100 parts, one more of hydro-

* Glucosides are named from the presence of glucose, or grape sugar, among the elements of their decomposition.

† Some chemists have classed Solanine with picrotoxine and digitaline among the glucosides.



separately.

These may
1. *In substanc*
1. In subst
ing the substa
microscopic ex
odour of their
lime; *d.* by th
of the same; *e.*
by their solubil
a. On inspec
picrotoxine, an
brucine, digital
the exception o
colourless, or sl
digitaline, and
cantharidine, an
morphine, picro
strychnine squa
may be well to
masses and deta
sometimes sold a
b. When heat
the list behave a

perature, leaving no ash. *Digitaline* darkens, melts slowly a brown liquid, smokes abundantly, leaves a black swollen odour of the drug. *Morphine* sublimes before melting, efies slowly into a black fluid, dries and melts again, gives a dense smoke, and swells into an abundant ash: odour as of eing. *Picrotoxine* melts slowly, smokes slightly, leaves a ty ash: odour slight, as of singeing. *Solanine* discolours, s very slowly, smokes abundantly, swells and spreads into a y ash: odour as of baked apple. *Strychnine* sublimes before ing, liquefies slowly into a dark brown fluid, gives off a dense ke, and leaves a moderately bulky ash: odour, aromatic and eable. *Veratrine* liquefies readily into a yellow fluid, gives n abundant vapour, spreads into a bulky carbonaceous layer : ır as of mice, and irritating.*

I have ascertained with respect to the substances in the list, facts which, with the subliming temperatures of a few of the e important inorganic poisons, make up the following e:—

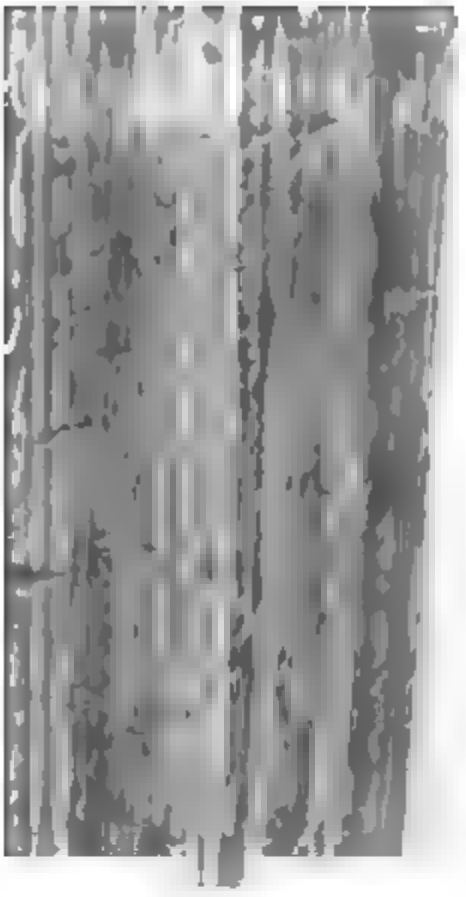
ublime as white vapour, without change of form or olour.	Corrosive sublimate	200°
	Cantharidine . .	212°
	Calomel	240°
	Arsenious acid . .	280°

		Sublime.	*Melt.*
limes without change of colour, id is wholly dissipated in pour.	Oxalic acid	180°	280°
ime, melt, and yield carbo- eous residue.	Morphine	330°	340°
	Strychnine	345°	430°

		Melt.	*Sublime.*
hange colour, sublime, and it carbon.	Aconitine	140°	400°
	Atropine	150°	280°
	Veratrine	200°	360°
	Brucine	240°	400°
	Digitaline	310°	310°
	Picrotoxine	320°	320°
	Solanine	420°	420°

		Decrepitates.	*Sublimes.*	*Chars.*
ites, sublimes and scantily, rs.	Tartar emetic	380°	480°	550°

e noted that the odour varies somewhat with the quantity of stage of the sublimation, and the distance from the nostrils.



which straight c
and feathery forn
and other defined
the sublimation
which octahedra
Of the process
best results are c
p. 405) is heated
driven off.

The reactions o
the solutions of t
respond well to th
with carbazotic ac
sublimates respond
several well-mark
526). The crystal
characteristic. Th
the test of sulphuri

e. The effect of
nitric acid, is seen

It will be seen t
the ten substances
the table is distingu
is marked by negati
strychnine, and mo

	Sulphuric Acid.			Nitric Acid.
	Cold.	*Warm.*	*Hot.*	
Cantharidine . .	0	0	0	0
Strychnine. . .	0	0	yellow[1]	pink[1]
Brucine. . . .	0	0	yellow[2]	red[2]
Morphine . . .	0	0	brown	orange[3]
Atropine . . .	0	0	brown[3]	0
Aconitine . . .	0	brown	black	0
Picrotoxine . .	0	yellow	brown	0
Veratrine . . .	orange[3]	scarlet	claret	∎
Digitaline . . .	red-brown[1]	red-brown[2]	red-brown[3]	0
Solanine . . .	yellow[2]	brown[2]	brown[3]	0

of the same substances when simply heated; and they are more irritating.*

f. The solubility of these poisons in the several menstrua while it may be made to contribute to their diagnosis, may also assist us in devising the best methods of procedure in order to extract them from organic liquids. In the following summaries the poisons are placed in the order of their solubility, beginning with the most insoluble. The figures (from Wormley) show the number of parts of the several menstrua required for solution.

Water (*cold*):—Strychnine (8333); veratrine (7860); morphine (4166); aconitine (1783); solanine (1750); brucine (900); atropine (414); picrotoxine (150); digitaline very soluble.

Ether:—Solanine (9000); morphine (7725); strychnine (1400); aconitine (777); brucine (440); veratrine (108); atropine, picrotoxine and digitaline very soluble.

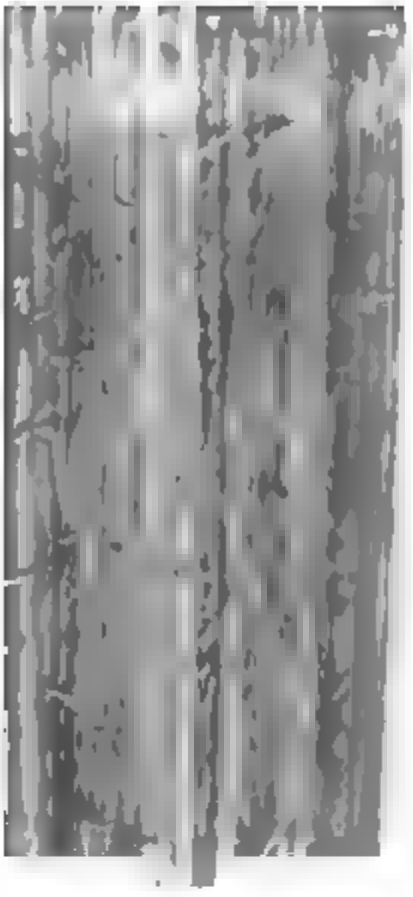
Chloroform:—Solanine (50,000); morphine (6550); strychnine (8); the rest freely soluble.

Absolute Alcohol.—Strychnine insoluble; brucine soluble.

Amylic Alcohol:—Solanine (1061); digitaline sparingly soluble; morphine (133); strychnine (122); veratrine, brucine, atropine, aconitine, and picrotoxine, freely soluble.

Benzole.—Solanine insoluble; the remainder freely soluble.

* In some notes of the reactions of the alkaloids with which I have been favoured by Dr. Silver, for instance, atropine and daturine, treated by sulphuric acid, and heated, are stated to evolve an odour resembling wild honey, or preserved rose leaves. The odour of heated atropine does not answer to this description.



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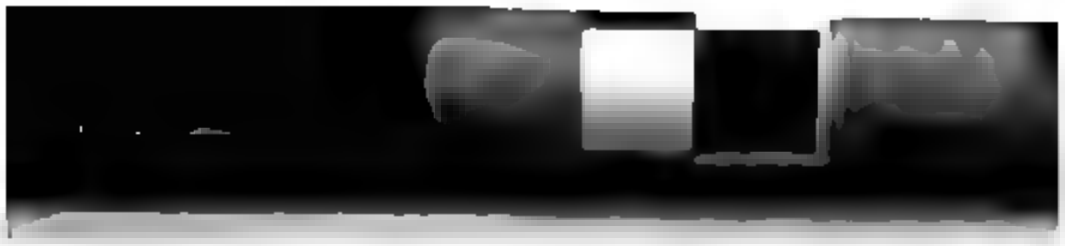
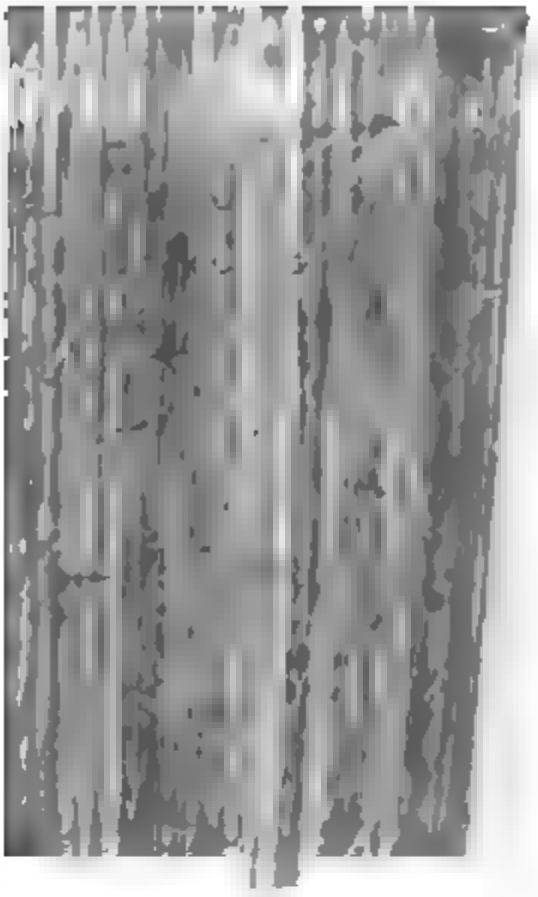


as well as to operate with the smallest quantities, the proper course is to place a drop of the liquid containing the alkaloid on a glass disk or slide, to add a drop of the liquid reagent, and to note first the immediate or proximate effect; then the change that takes place after such an interval as half an hour or an hour; and, lastly, the character of the dry spot left by evaporation: these several observations to be made under the microscope. But before we proceed to apply the tests, we ought to have a more definite notion than is generally entertained of the characters of crystalline deposits, and of the features by which they may be identified.

When a drop of a solution of an alkaloid is placed on a glass disk or slide, and treated with a liquid reagent, the immediate effect is a precipitate, more or less dense, or a slight opalescence; or the solution may retain its transparency. The dense precipitates, when examined by the microscope, are either amorphous and so continue till dry, or they consist of a gelatinous or curdy matter, out of which well-defined crystals more or less quickly develope themselves, some floating on the surface, some attaching themselves to the glass, some occupying the depth of the liquid. The opalescent liquid, when examined by the microscope, is found to owe its changed appearance to the instantaneous development of crystals, which, however, may form in a drop which does not seem to have undergone any change. If the spots are examined after the lapse of an hour or less, some precipitates are found to have undergone no change, others to have passed from the amorphous to the crystalline form; and sometimes the drop, which was quite clear at first, grows more or less turbid from the slow formation of crystals. If, lastly, we examine the dry spot, we may find it to consist of the unchanged amorphous precipitate; or of crystalline forms, central, marginal, or both, mixed, when the liquid reagent is a saline solution, and does not happen to have been well proportioned to the solution of the alkaloid, with crystals of the unexpended reagent.

Now a very slight familiarity with microscopic crystals teaches the somewhat discouraging lesson that, obtain them as we will—by sublimation, by liquid applications to dry spots, or by reaction of liquid with liquid—we cannot secure uniformity of appearance, or even the certain production of the crystalline form. More extended experience, however, removes part of the difficulty by teaching us that many perplexing differences of form arise out of the various groupings of the same elementary crystal. So that if we can ascertain by repeated experiment and microscopic examination what that elementary crystal is, our difficulty is



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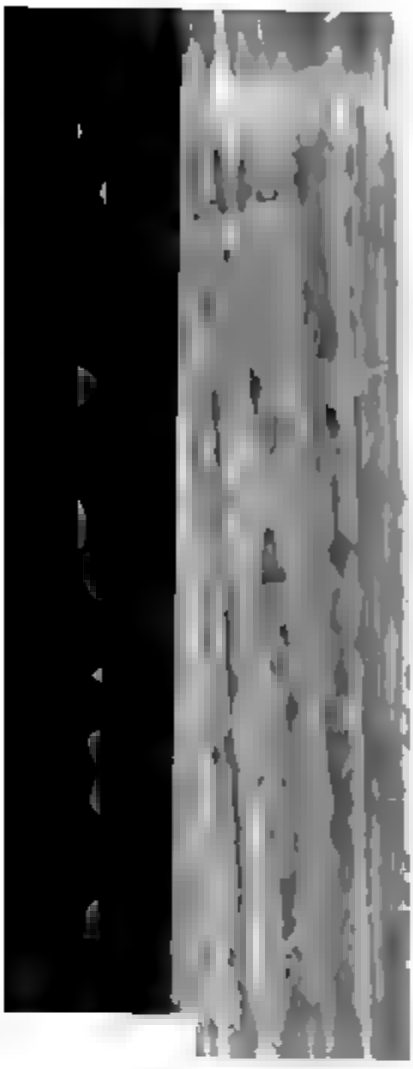
iodine with sulphuric acid. The double group of needles radiating from a point (11) occurring, as it does, with crystals of straight and curved outline (5 and 6) in the reaction of brucine with the red prussiate of potash, is eminently characteristic. Such forms radiating from a point are common in many marginal crystals—e.g., *strychnine* with iodo-iodide of potassium, and *morphine* with hydrochloric acid. Tufts (12) are common in deep drops, when in shallower ones groups of needles or fine prisms abound. The disks faintly marked (13), thicker and coarser (14), and with curved edges (15), are blended with other crystalline forms; those of (15) being common in the reaction of strychnine with perchloride of iron. The star-fish crystal (16) is seen, large and perfect, in the reaction of *brucine* with nitroprusside of sodium. The dendritic or arborescent form (17) occurs in the reaction of *strychnine* with terchloride of gold, and in a marked manner with carbazotic acid, the elementary form which specially marks that reaction being the curved claw-like figure (18). Dendritic forms are also common in deposits from crystalline solutions. Several of these reactions were described in the last edition of this work for the first time; after repeated experiment and frequent comparison with other reactions.

The reactions of strychnine with bichromate of potash and ferridcyanide of potassium admit of the strongest confirmation by a simple modification of the colour test. Bichromate of potash and ferridcyanide of potassium being two of the colour-developing substances named at p. 574, the addition of strong sulphuric acid to the crystals is all that is required to complete the colour test. If then a droplet of sulphuric acid be placed at the margin of the crusts the characteristic rich blue tint passing to mulberry and light red will be developed as each group of crystals, or portion of the spot, is touched by the acid; and if this reaction be watched under the microscope, it is found to continue for several minutes. When the dry spot of brucine is similarly treated, the acid brings out an orange tint fading to light yellow, while the dry spot of morphine shows no immediate change of tint. The colour tests for strychnine cannot be applied in a more conclusive manner.

3. In Organic Mixtures.—Most of the methods which have been employed for extracting the alkaloids from organic mixtures are founded on the principles first set forth by M. Stas, of Brussels, in the year 1851—principles that had already been practically applied in separating the alkaloids from the vegetable substances of which they form part. The alkaloids unite with acids to form salts soluble in water and in alcohol; these salts are



liquid.

The method founded on these pr
distinct operations. 1. The organic
its weight of absolute alcohol, and tr
tartaric or oxalic acid, is heated in a
till brought to a state to pass the
mixture, being allowed to cool, is filte
rated to dryness. 2. This dry residu
tilled water, is then treated with bi
alkaloid set free. 3. The resulting
dissolved or suspended, is poured in
five times its bulk of ether, briskly
rest. The ether floats on the surface ho
4. A part of this ethereal solution is
glass and allowed to evaporate. It m
or a *fixed* alkaloid. If volatile, oily
glass; if fixed, a deposit with some tr
tion. From this point the procedure
thus obtained.

For the *volatile liquid alkaloids* th
From fifteen to thirty grains of a stro
or soda are added to the liquid in the
shaken, and again allowed to stand.
next drawn off by a pipette, and a
acidified with sulphuric acid. The
leaving the alkaloid as sulphate in t
excess of caustic potash or soda. The
be again shaken up with ether and
evaporating the ethereal solution, th
in a state of sufficient purity.

of alcohol, and allowed to evaporate, may yield crystals of the alkaloid. But if not, a few drops of water slightly acidulated with sulphuric acid are added, and the watch-glass carefully rotated. A soluble sulphate of the alkaloid is thus formed, which being carefully drawn off, or filtered, may be neutralized by a strong solution of carbonate of soda, the alkaloid set free, dissolved by absolute alcohol, and evaporated. Crystals will now form.*

II. THE LIQUID VOLATILE ALKALOIDS.

These alkaloids are distinguished from the fixed alkaloids by their liquid form, and from each other by several satisfactory tests.

The odour of coniine is that of stale tobacco, or dead mice, while that of most, if not of all, specimens of nicotine is agreeable. A drop of coniine let fall on filtering paper, forms a round defined stain of a clear yellow colour, while the stain of nicotine is darker and less clear, and may have a tint of green. If now a drop of distilled water is placed at the margin of the two stains, that of coniine remains intact, while that of nicotine is more or less completely dissolved. If, again, two watch-glasses are filled with distilled water, a drop of coniine will not mix with it, but forms a greasy scum on the surface; while a drop of nicotine dissolves easily and completely.

Now place three drops from each watch-glass on six glass disks or slides, and add the following reagents:—1. Bichloride of platinum. 2. Corrosive sublimate. 3. Carbazotic acid.

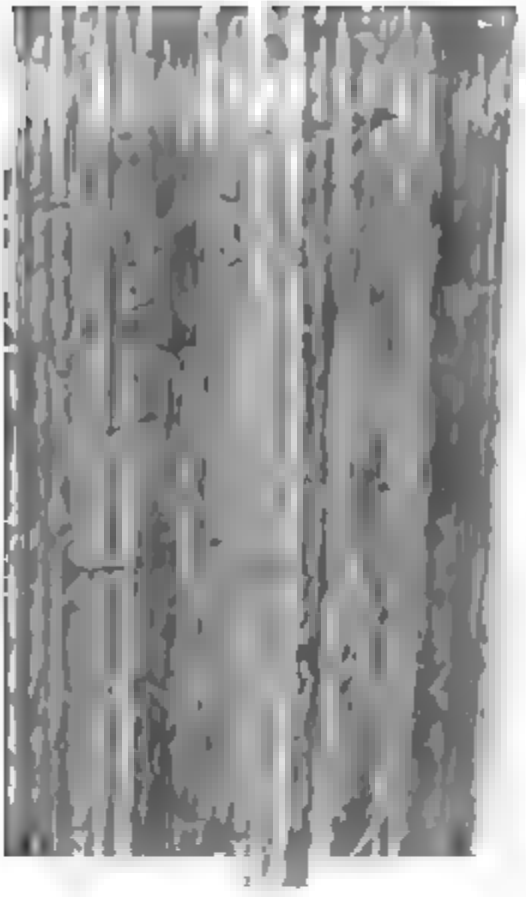
1. *Bichloride of Platinum.*—This gives an immediate visible precipitate with the solution of *nicotine*, but none with that of coniine. The precipitate examined under the microscope is flocculent, and after a time shows coarse dendritic forms.

2. *Corrosive sublimate.*—With *nicotine*, corrosive sublimate yields very distinct groups of truncated plates, radiating from a centre, or winged forms; with coniine, an amorphous precipitate.

3. *Carbazotic acid.*—With liquid solutions of the two alkaloids, this reagent yields the precipitates depicted at p. 593.

Lastly, coniine is distinguished from nicotine by giving with hydrochloric acid, or its vapour, groups of needles; and nicotine from coniine by assuming a blood-red colour with chlorine.

* This method of Stas for the fixed alkaloids has been simplified by Otto; also by Messrs. Rodgers and Girdwood, who employ hydrochloric acid instead of the tartaric or oxalic, and chloroform instead of ether. Professor Bloxam prefers benzole to chloroform, and Uslar and Erdmann use amylic alcohol, while for extracting strychnine from beer Professors Graham and Hofmann availed themselves of the property which animal charcoal possesses of separating the alkaloids from their solutions. For a more precise account of all the successive steps of extraction of the alkaloids, fixed and volatile, the reader must be referred to works on Toxicology, or to such special treatises as Dr. Wormley's 'Micro-Chemistry of Poisons,' p. 411 *et seq.*



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succeeded to the baronetcy in 1821, and died in 1845, leaving six daughters, but no son. He was succeeded by his brother Edward, who had taken large estates under the will of a Miss Doughty, whose name he assumed. He died in 1853, leaving a widow and one daughter—the Lady and Miss Katherine Doughty (afterwards Lady Radcliffe) who played so important a part in this long litigation. Sir Edward was succeeded by his brother James, who, up to that time had lived in Paris; to which city, after his death in 1862, his widow returned. She was a descendant of the old French family of Bourbon Conti, by an English father, Mr. Seymour, of Knoyle. By her James Tichborne had two daughters who died young, and two sons, Roger Charles and Alfred Joseph. Roger was believed to have perished at sea in 1854; and was succeeded by his brother Alfred. He married, and died in 1866, leaving one son, whose rights the defendant assailed. The trustees to the infant heir, having let Tichborne Park to a Colonel Lushington, he was served with a writ of ejectment; and in this way the issue was raised in the Common Pleas.

The Tichborne case could have had no existence but for the strange character of the mother of Roger Charles Tichborne. She was described by her husband, in a letter to her father, as a perverse, exacting woman, a slattern, and a scold; fretting her son Roger with misplaced anxieties; hating, misrepresenting, and abusing her husband's relatives, and everything English; and treating her husband's younger brother, their guest, with unwomanly rudeness. French priests, who knew her well, bore witness to her *idée fixe* and *tête malade*, and the letter just referred to (suppressing some circumstances which would astonish her father) reads like the description of a case of moral mania. Her conduct at Tichborne showed that her unsoundness had culminated in delusional insanity. She stood alone in the strange belief that her son Roger had not been drowned off the coast of South America in 1854, but had been picked up and carried to Melbourne; and she fed this fancy with tales of shipwreck told by tramps disguised as sailors. On her return to Paris, after her husband's death, she caused advertisements to be inserted in the English and Australian papers, which were brought to the knowledge of the defendant, and wrote letters that insured the co-operation of others.

The defendant's Australian letters staggered even this poor lady. She did not recognise in them the handwriting or the style of her son Roger, knew nothing whatever of a brown mark on his side, of the St. Vitus's dance which he said he had

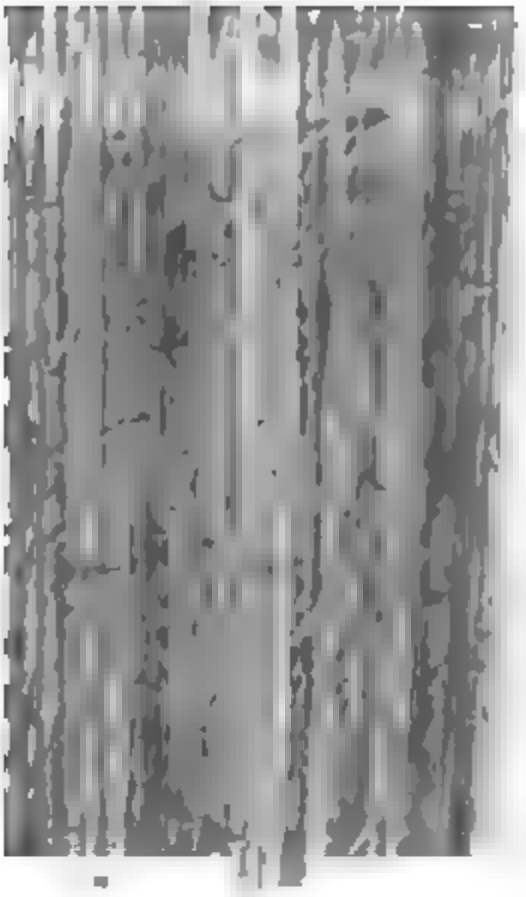
had when a child; or of a Brighton card case, which, had it really happened, she must have known about, and could not have forgotten. She knew, too, that Roger had never seen the grandfather or grandmother about whom this man made inquiries. At that time his ignorance of all that related to her, of almost every fact and incident in the life of Roger Tichborne, was complete. He did not know her Christian names; and he described her, who was leanness itself, as a tall, large, stout woman. He was ignorant of the fact that both Roger and his brother Alfred were born at Paris; did not know at what age Roger left France, that he was educated at Stonyhurst, and became an officer in the Carabineers; knew nothing of the family property, of the agent who managed it, or the name of the lawyer who made Roger's will. For knowledge of these and such like matters, he substituted guesses ludicrously wide of the mark—his own personal peculiarities, and facts in Arthur Orton's history; or statements revealing the same knowledge of persons and events, places and dates, as he was proved to have had. In Australia he took naturally to the trade of butcher, to which Arthur Orton was bred, or the congenial pursuits of stock-keeper and rough rider; consorted with the scum of the population, and married a woman of low origin. But Lady Tichborne was proof against facts and probabilities, arguments and remonstrances. She insisted on acknowledging the claimant as her son, and made the needful arrangements for bringing him to England. He left Australia in company with Bogle, a black, who had been servant at Tichborne Park; and in England, associated with himself three common soldiers, two of whom had been Roger's military servants, secured the services of a Hampshire antiquary and archæologist, obtained the command of money, procured efficient legal assistance, and with lists of the teaching staff at Stonyhurst, papers from the Horse Guards and Lloyds', with the diaries, letters, and clothes of Roger Tichborne, and constant intercourse with Roger's mother to help him, prepared himself for the work of personation.

All his early proceedings in England were as consistent with the theory that he was Arthur Orton as they were inconsistent with the supposition that he might be Roger Tichborne. He reconnoitred Wapping, and subsidized members of the Orton family; but he avoided Roger's relatives and intimates, as long and as much as he could; and, when he saw them, did not recognise them, not even the cousin whom Roger had loved, and whom he alleged that he had seduced; and he mistook one relative for another, and an uncle of 70 for a servant of 30. He did not even recognise the handwriting of Roger's father. He was in no hurry to

join the lady he called his mother in Paris; and when there, instead of hastening to meet her, he pretended illness, and received her reluctantly at his lodgings in a darkened room, lying on the bed with his clothes on, and his face turned to the wall. He did not pretend to recognise *her;* but she found his face to be like his father's, and his ears like his uncle's. While in England, the defendant stealthily visited the localities in which he was interested, and picked up scraps of information chiefly from common soldiers who had known Roger in the Carabineers, and from other persons in the same rank of life; and with information so acquired surprised and convinced many common people, and a few persons of higher rank. But most of Roger's many relatives, his Paris tutors, the old family servants, his fellow-pupils at Stonyhurst, several officers, and some private soldiers of the Carabineers, the agent of the family estates (Roger's friend and confidant), and, above all, the cousin to whom Roger was tenderly attached, and her mother on her death-bed, testified that the defendant was not Roger Tichborne. Their testimony, however, was rebutted by that of witnesses as numerous, but less intimately acquainted with Roger. On the other hand, the young woman to whom Arthur Orton, when a young man, had made love, and upwards of forty neighbours of the Ortons, identified him as Orton. But witnesses nearly as numerous, but less consistent in their testimony, and, on the whole, less entitled to credit, affirmed that he was not Arthur Orton.

The evidence that he was not Roger Tichborne received the strongest possible support from the personal appearance and conduct of the defendant, his want of culture and strange ignorance of all that gentlemen, educated men, and officers in the army come to know, which Roger Tichborne must have learnt, and could not have forgotten. It is impossible to imagine evidence more complete than that which the letters, and statements under cross-examination of the defendant, afford of low culture, gross ignorance of things and names which to educated men are as household words, and vulgar depravity. And though he contrived to keep his own secret, and occasionally displayed a ready wit, and could assume the manners and bearing of a gentleman, he exhibited a curious absence of that power of acquiring knowledge which culture supplies, blended with a negligent and slovenly management of that part of his own case which devolved upon himself.

A minute account of this strange case, so humiliating yet so instructive, and so suggestive of important legal reforms, must be sought in the current publications of the day. Its medico-legal bearings will be understood from what follows.



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answer to the question. The transformation is incredible, if not impossible.

b. Roger Tichborne's nose was not aquiline, was flat and broad at the end, with large open nostrils, and had a decided twist to the right. His ears, of average size, tapered below, and were without pendulous lobes. His eyes were blue, with long black lashes. His hair was lank, and dark brown verging on black, and his complexion sallow. The expression of his face was variously described as pensive, woe-begone, and wearing a look of surprise and alarm. He had a weak but pleasant voice. In face, as in person, he resembled his mother, not the Tichbornes, and had a French look, and always when he spoke a French accent. The defendant, on the other hand, has a slightly aquiline straight nose, with well-formed nostrils, and rounded end; large ears with long detached lobes; brown eyes, and hair of the same colour, and disposed to curl; his voice has been described as harsh, hoarse, or gruff; and he speaks vernacular English without a trace of French accent. His whole aspect and demeanour are as English as those of Roger were French, and while Roger resembled his mother, he bears some resemblance to the Tichbornes, but still more to the Ortons.

In the comparison of face with face we are assisted by two excellent daguerreotypes of Roger Tichborne taken at Chili in 1853, and photographs of the defendant dated 1874; and we are indebted to Mr. Piercy,* the portrait painter, skilled in various art-processes, photography among the number, for so handling the two portraits as to be able to compare the features of the one face with those of the other. This was done by creating from the originals two untouched transparencies on glass, in which the lines drawn from the inner angle of the eye to the parting between the lips are equal.† The point of view of the two portraits is so nearly the same as to justify the assertion that "it is physically impossible that they could have been taken from the same person:" that, "in fact, the faces are so far from being alike, that they are of opposed types." This decided expression of opinion is fully borne out by a detailed examination of the eyes, ears, and nose taken in conjunction with the mouth.

1. *The eyes.*—The brows of Roger are wide apart and singularly well defined, and the eyes tend upward from the nose;

* "A Crucial Test in Cases of Disputed Identity, with Illustrations." By Frederick Piercy, Memorial Portrait Painter. 1873.

† Having carefully examined these transparencies, we can commend the method adopted as one that may be advantageously employed in future cases of disputed identity. Its value is not seriously impaired by the hostile criticisms with which we have become acquainted.

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length being largely due to the detached pendulous lobe, which in Roger had no existence. The dotted lines of the two ears make this difference very apparent.*

The noses and mouths, taken together, display differences scarcely less marked. The nose of the defendant, with which the lips may be said to harmonize, is "a narrow one in a fat face;" that of Roger, "a broad one, with inflated nostrils, in a thin face." The central groove which joins the nose to the upper lip

Fig. 199.

is narrow in the defendant, wide in Roger—a difference well shown by the dotted circles in the figures annexed. The two mouths are also quite different in character.

If, then, we compare the form and face of Roger with those of the defendant, there are good grounds for answering the first question in the negative. The personal appearance of the defendant is not such as Roger Tichborne would have presented after the lapse of 20 years.

2. Arthur Orton, when he presented himself at the Shipping Register office, a growing lad of 14, was entered on the books as having blue eyes, a fair complexion, and light hair, and as being free from personal marks. When he again presented himself at 18, he was measured in his shoes, and found to be 5 feet 9½ inches. This was the only addition made to the Register, though the entries preceding and following take note of personal marks, and of small-pox marks among the number. It is a just inference, therefore, that at 18 years of age he had no personal marks that attracted attention—that he was not pitted with small-pox, did not wear earrings, and had no conspicuous scars on hands or face.†

* Judging by the published photographs, the ear of the defendant closely resembles in size and shape that of George Orton, senior, and in size that of George Orton, junior.

† Being desirous of ascertaining for myself whether Arthur Orton was measured in his shoes, I went to the office of the Registrar-General of Shipping, and Seamen, and learnt that applicants were always measured in their

In further comparing the defendant with Arthur Orton, we shall, as before, take first the person, then the face.

In *person* the lad Arthur Orton, according to the evidence of the witnesses on both sides, was a big, fat, awkward boy, with a slouching or shuffling gait, more or less in-kneed; known as the "fat boy" and as "bullocky Orton." A witness for the defence had weighed him, and found him 13½ stone; and, allowing half an inch for shoes, he measured at 18 what the defendant measures now—5 feet 9 inches. The lad of 18 was, therefore, for his age, as remarkable for size as the defendant is now. As to stature, it must be admitted (as stated at p. 8) that the fact of men, taken one with another, growing two inches after 18, creates a difficulty in admitting the identity of the two persons. But as there are many youths who stop growing even before 18, it is possible that Arthur Orton belonged to this exceptional group. It is also possible that the slouching gait of the lad may have been improved with age, and the altered circumstances of the defendant, who for 8 years has been acting the part of a gentleman.

In *face and feature* the defendant is what the woodcuts represent him to be. The photographs from which these are taken have an unmistakeable resemblance to members of the Orton family—a resemblance strongly insisted upon by most of the witnesses for the prosecution, and admitted by several witnesses for the defence. That Arthur Orton had light hair may be taken as an undoubted fact, and that he had a light eye or a blue one as scarcely less certain.* The defendant's hair and eyes are certainly not light: they are some shade of brown, described by an Australian witness as *dun-coloured*. In complexion there is no difference; and there is no fact better established than that Arthur Orton was not pitted with small-pox, except perhaps that other fact that he had St. Vitus's dance when a child, and that the disease left behind it a habit of twitching the eyebrow, which the defendant also has. It should be added that almost all the witnesses for the defence gave Arthur Orton big hands and feet, and several of them a big head also. The defendant's hands and feet are not large, nor his head disproportioned to his size. But

shoes. I was also allowed to inspect the Register, and there found evidence of the attention paid to personal marks, whether open to observation, as on the face and hands, or to be found on parts usually concealed by clothes. The following are extracts from the Register for the days preceding and following Arthur Orton's visit:—"scar on knee," "scar on forehead," "small-pox," "scar on each arm," "three scars on left arm," "scar on forehead," "scar on right thigh." (G.)

* The Register, two witnesses for the defence and one for the prosecution, describe the eyes as *blue*, and one for the defence as *light*. There is no conflicting evidence on this point.

it is possible that in the big, stout, ungainly boy, carrying his fat chiefly on his limbs, not on his body, the hands and feet may have appeared large. Be this as it may, the fact remains that the light hair and eye of Arthur Orton must have changed to brown in order that Arthur Orton and the defendant may be accepted as identical. These changes, taken together, must be pronounced improbable. That they are impossible cannot be affirmed till the attention of scientific men has been distinctly drawn to the question, and time has been allowed for the collection of facts bearing upon it.

If now we take the figure and face together, we infer that the youth Arthur Orton might have developed into the defendant if he stopped growing at 18; if his hands and feet came to appear less out of proportion to the rest of his body; if he improved in gait and bearing; and if the light hair and eye underwent a change of colour, and assumed a darker tint. But it is much easier to believe that these changes did happen, than it is to doubt the reality of the recognition of the defendant as Arthur Orton by upwards of 40 witnesses (among whom Mary Ann Loder from Wapping, Donna Hayley from Melipilla, and Mrs. McAlister from Australia, are specially deserving of mention), whose firm, decisive, and unshaken testimony must be admitted greatly to outweigh the balance of adverse testimony borne by the smaller number of witnesses for the defence remaining after the subtraction of those whose expenses were disallowed, or who were otherwise discredited.

3. Roger Tichborne had no congenital marks; but he must have had scars of an issue on the left shoulder, of repeated bleedings on the arms, and of single lancet cuts on the ankles and temple; as well as tattoo marks on the left arm of a heart, cross, and anchor, to which Lord Bellew alleged that he added the initials R. C. T. None of these marks are to be found on the defendant, who, on the other hand, adduced as proof of identity a congenital brown mark on the left side, of which Roger's mother knew nothing; and he had a twitching of the eyebrows, such as followed Arthur Orton's attack of St. Vitus's dance, from which Roger Tichborne was proved to be free. These facts are fatal to the defendant's claim to identity with Roger Tichborne.*

On the question whether he and Arthur Orton are one and the same person much light is thrown by the physical marks. The defendant has a well-marked linear scar of an incised wound

* The deformity of the left thumb (which the surgical witnesses for the prosecution were satisfied had been recently produced, though Sir W. Ferguson attributed it to accident) may be safely disregarded as quite immaterial.

on the back of the head, answering to a cut from an oyster-shell which a witness for the defence saw inflicted; a scar on the right eyebrow, and across the nose, which seems to have been broken; and the scar of a cut on the left ankle. Other scars (one inside the lower lip), and several small scars on the arms and legs, are unimportant, except as showing that the skin was apt to be so marked. It is possible, too (for the evidence on these points is very conflicting), that he had scars on the left hand, and left cheek.

Of the long, narrow, light-brown mark on the left side following the line of the ribs, it should be observed that there is no better reason for believing it to be congenital than the assertion of the defendant. It has not the deep, distinct colour of most congenital marks, but such a tint as the skin often assumes, and sometimes retains, for months or even years, after severe attacks of erysipelas, and after the application of blisters or mustard plasters. It might have faded from a brighter colour in childhood, or have resulted later in life from the pressure or friction of some article of dress.*

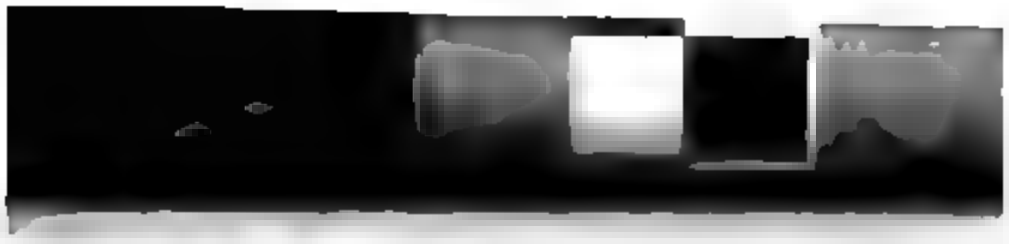
But there are two marks to which a peculiar interest attaches; for the defendant professes ignorance of the way in which they were brought about. The one is above the left wrist; the other near the insertion of the left deltoid muscle. The mark above the wrist was probably produced by caustic, and is quite consistent with the belief that the letters A. O. had once been tattooed there. Donna Hayley saw the two letters A. O. about the size of a shilling on the fore-arm (uncertain which arm); and Mrs. Mina Jury, who also saw the marks, thought they were on the left arm. The mark on the upper arm, the size of a florin, is a group of round scars, with intervals of healthy skin, and is such a scar as would be produced by vaccine lymph inserted at several points.†

The personal marks found on the defendant are, therefore, on the whole favourable to his identification with Arthur Orton.

4. On the assumption that the defendant is Roger Tichborne, it ought to appear that after the wreck in 1854 the defendant had led a life of such extreme hardship, had sustained such a severe injury, or had had some such disease of brain or nervous system, as would account for the loss of memory of the things

* I give the following fact in illustration:—A gentleman who wears a double truss, with circular wooden pads pressing equally on both groins, has a distinct brown stain on the left side, none on the right, and the left thigh is marked by many freckles, from which the right is nearly free. The stains so often seen on the thighs, where they are separated by the scrotum, are in this case very distinct.

† Such a procedure would effect the removal of a tattoo mark of some size. (C.)



best known to Roger Tichborne. Of this there is no evidence whatever. If we could assume the literal truth of the improbable and inconsistent story of the rescue from shipwreck, it is clear that the very day after he landed in Australia, the defendant obtained employment, and discharged with intelligence the duties he undertook; and his later correspondence with the Cantro of Malipilla, whose name he had assumed, exhibits a singularly tenacious memory of the names and persons of those with whom he had spent eighteen months many years before. If, then, the question is made to assume this form—Were the defendant's misstatements respecting the whole life of Roger Tichborne the result of ignorance, or lapse of memory? there is but one possible answer: what has been represented on his behalf as want of memory could have been nothing less than sheer ignorance of the facts and events referred to. The same memory that claimed to recollect the name of a dog, or the number of a trooper's horse, could not have failed when tested with the Christian names of his mother, the handwriting of his father, his place of birth, his Paris residences, the companions of his childhood and youth, the college where he was educated, the studies he pursued, the examinations he passed, the relatives in whose houses he was always a welcome guest, the agent with whom he was in constant correspondence, the lawyer who made his will, the friends who helped him, the gallant soldier who gave him his commission, and the long, painful correspondence which passed between himself and the mother of the lady whom he would have made his wife. Nor ought the fact to be overlooked that the defendant never professed to have forgotten any circumstance connected with the lives of Roger Tichborne and his relatives. Roger's mother signs her Australian letter H. F. Tichborne. He does not say that he has forgotten her Christian names, which Roger knew well; but for *Henriette Felicité* he substitutes the homely English names, *Hannah Frances*. Roger took leave of his dying grandfather, Mr. Seymour, at Bath. The defendant does not pretend to have forgotten the event, but shifts the scene to Knoyle. It was therefore of the very essence of the claimant's case that he should display a tenacious and accurate memory. It was by the pretended exercise of it that he gained all his adherents. To admit the loss of it would have been fatal to his case.

Roger Tichborne's native language was French. He continued to speak it in France up to the age of 17, and frequently in England up to the age of 25. He acquired English later, and spoke it to the last with a French accent. The defendant could not

speak or read French; but he spoke Spanish as a man who had spent 18 months in South America might be expected to do. Assuming again the identity of the defendant with Roger Tichborne, had anything occurred to utterly destroy his knowledge of French? There is but one answer. It had not. The defendant spoke Spanish years after he had acquired it. What reason, then, could there be for his having altogether forgotten French if he had ever known it?* The memory which he actually displayed affords the best of all reasons for supposing that when he professed to have forgotten French, as when he grossly misstated the events of Roger's life, he was equally guilty of falsehood and deception.

The defendant, as shown among other things by the letters he wrote, was singularly tenacious of the habits he had formed. It is, therefore, a fair presumption that he would have retained at least a trace of the strong French accent with which Roger Tichborne always spoke English.

The medical evidence taken as a whole may, therefore, be pronounced to be in perfect keeping with the verdict which proclaimed the defendant to have perjured himself in claiming to be Roger Tichborne, and denying that he was Arthur Orton. If Roger was bled repeatedly in the arm (to say nothing of ankles and temple), if he had an issue on the left shoulder, kept open for two or three years, and if he was tattooed as alleged, the defendant is not Roger. If Arthur Orton had the letters A. O. tattooed above the left wrist, and they did not exceed half an inch in diameter, the scar in that position, of the cause of which the defendant alleges utter ignorance, is quite *consistent* with the assertion that he is Arthur Orton—an inference strengthened by the existence of a second scar equally unexplained, and not seriously weakened by the difficulties already admitted, when fairly weighed against the evidence of the many competent and credible witnesses who affirmed that the defendant sitting in court was no other than the Arthur Orton they had known at Wapping, in South America, and in Australia.†

* The evidence of certain witnesses, who alleged that they had forgotten their native tongue, is obviously inapplicable to this case.

† This case has displayed in an unusual degree that conflict of evidence which has marked all cases of disputed identity, and it should be added in justice to those who have become professionally interested in it that what transpires in a court of law is not all that may be believed without the imputation of excessive credulity, that many statements calculated to impress the mind very strongly are shut out from a court of law by technical rules of evidence, and that the unwise usage which allows the parties to a suit to choose their own skilled witnesses is one calculated to throw doubt on the very facts which should be the least open to objection.

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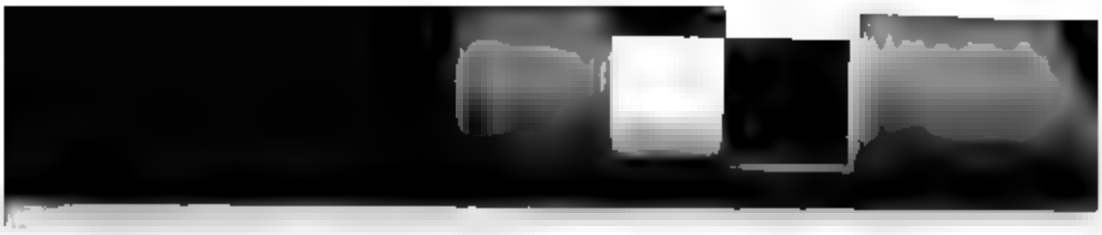

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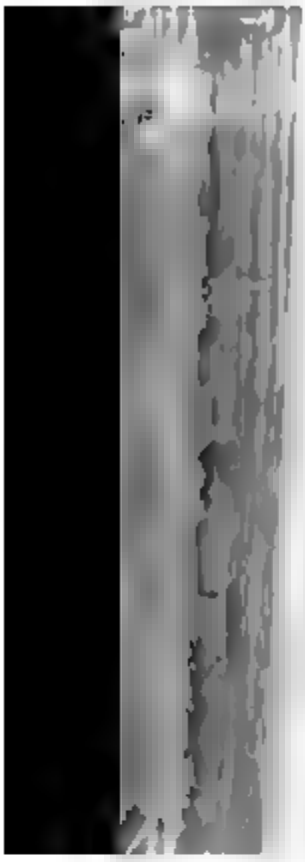

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